THE

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THE

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TELEGRAPHY BY ELECTRIC WAVES.

FEW of the recent achievements of science will appeal more strongly to the popular imagination than the new system of telegraphy invented by Signor Guglielmo Marconi, which last Friday evening was expounded to a crowded audience at the Royal Institution by Mr. Preece. To be able to send telegraphic messages through walls of houses and other obstructions which are opaque to sound and light, is a feat which a few years ago would have suggested the tales of the Arabian Nights; to-day, however, through the technical knowledge and practical ability of Signor Marconi, it has become an accomplished fact.

The Marconi system of telegraphy, though of great scientific interest, and which, we believe, will also be of great practical value when fully developed, does not represent any great advance on what was previously known. Signor Marconi's invention is neither more nor less than a system of telegraphy by Hertzian waves.

It is not more than ten years ago since Hertz proved experimentally the possibility of producing electric waves which could pass through doors, walls, &c., and excite a spark in a resonator tuned to the same frequency as the transmitter. But this was not done over a greater distance than a few yards. Marconi has succeeded in making the resonator work a Morse recording instrument, and print the telegraphic message, at a distance of nearly 9 miles.

The receiver used by Marconi is not the Hertzian resonator pure and simple, but a combination of this instrument with a much more sensitive detector of electric waves which was discovered in 1890 by M. Edouard Branly. This instrument of Branly's consisted of a glass tube containing metallic filings, connected to an external circuit by platinum electrodes fused through its ends. It has been called by Prof. Lodge "the coherer," on account of the similarity of its action to that of a detector, discovered by himself about the same date. In Lodge's coherer, the end of a metal wire was pressed gently against a metal plate. When a current passed through this joint, a kind of electric weld was produced, and the resistance of the joint was greatly reduced. Lodge's theory is that a similar process takes place among the filings contained in the glass tube in Branly's apparatus, and hence the name.

Marconi connects the tuned plates of the Hertzian resonator to the terminals of the coherer, in order to get the advantage of the intensified effect of the electric waves, due to resonance in combination with the extreme sensitiveness of the coherer. Marconi has evidently done a great deal of careful experimental work in discovering the best materials to use, and the most effective arrangements. Nickel filings of uniform grain, mixed with a small percentage of silver filings and a trace of mercury, he has found to be superior to the iron filings recommended by Lodge. A single cell lies in wait in the coherer circuit, to force the current through when the resist-

ance in the filings is broken down by the electric waves. This feeble current, insufficient in itself to actuate a telegraphic instrument directly, acts upon a delicate relay, which throws a more powerful battery into the circuits where the heavier work has to be done. The trembler for restoring the resistance of the coherer is ingeniously constructed, and, as stated by Mr. Preece, can be itself used as a sounder for reading the telegraphic messages.

All the other details of Marconi's apparatus appear to have been carefully worked out; and he has succeeded in converting mere laboratory experiments into a practical system of telegraphy. As Mr. Preece remarked in his peroration, our *savants* have long known of the existence of the egg, but Signor Marconi had to show them the Christopher Columbus trick of making it stand on its end.

Mr. Preece commenced his lecture with a description of his own experiments in telegraphy by electric waves. In these experiments, which are no doubt well known to our readers, the frequency of the waves amounted to hundreds per second, while in Marconi's system the frequency amounts to millions per second. This is one point in which the Marconi system excels the Preece system, since the E.M.F. generated in the receiver is *cæteris paribus* proportional to the frequency. Moreover, the E.M.F. employed in the Preece transmitter was immensely less than the E.M.F. used in the Marconi transmitter, and this again tells in favour of the Marconi system. The only superiority possessed by the Preece transmitter was in its larger coefficient of self-induction, but that was evidently insufficient to counteract the other disadvantages, since the range of the Marconi transmitter has already considerably exceeded that of Preece. As the lateral wires which constituted the transmitter and receiver of the Preece system require to be equal in length to the distance over which the signals are to be transmitted, it would be a misapplication of terms to call this system a system of telegraphy without wires.

The experiments shown by Mr. Preece with the Marconi apparatus were remarkably successful. It was indeed an uncanny sight to see, on a small box carried about in the hand, an electric bell which could be rung at any moment by some invisible agency. The invisible agency, we were told, was Signor Marconi in the dungeons, or in the library of the Royal Institution. If we had not been told by Mr. Preece, in the best Egyptian Hall style, that there was "no deception," we should have suspected a concealed Leclanché in the box.

One improvement made by Marconi in the transmitter appears to be of considerable importance, and has already effected a great extension in the range of transmission. This consists in putting one of the wings of the transmitter to earth, and raising the other to a considerable distance above the ground by means of a kite or a long pole. It was by means of this arrangement that the record range across the Bristol Channel was attained. It is difficult to see in what the superiority of the elevated transmitter consists. It might be supposed that it would enable the waves to reach the receiver without passing through hills or other solid obstructions which no doubt have a somewhat greater resistance than the air. But as the experiments were made over a level surface of water, this explanation does not appear to be satisfactory. Mr. Preece seems to think that the waves are deflected downwards by the inductive action of the electric charge in the earth. The point evidently requires a more thorough investigation than Mr. Preece appears to have given it.

If the range of transmission of the Marconi telegraph is to be increased, some method of getting a much greater power out of the transmitter must be devised. For the 9-mile range at present reached, it is necessary to employ an induction coil of 18 to 20 inches spark length. To double the distance would probably require double the size of coil, unless some other means is devised for increasing the energy of the waves. Mr. Preece gave us no indication in his lecture as to how this was to be done; indeed, on this and on some other points Mr. Preece gave little or no information.

We read some time ago, in a sensational magazine article foreshadowing the revelation of Marconi's invention, that the Marconi waves could penetrate metal almost as easily as any other obstruction, and pictures were drawn of the terrible effect that this would have on modern warfare. Gunpowder magazines might be exploded, and forts or ironclads blown up without coming within sight of them. Hitherto we had been taught that the chamber completely enclosed with metal was an absolutely safe place of refuge from all external electrical disturbance. Had Faraday or Clerk Maxwell left some kind of electrical disturbance out of account when they asked us to accept this now time honoured dogma of electrical science? The experiment on which the heretical statement in the magazine was evidently founded, was shown by Mr. Preece; and after seeing it, we are glad to say that there is still hope for the orthodox belief. A Marconi receiver was placed in a galvanised tank, which was then covered by a loose fitting lid. When a transmitter a few feet away was operated, the bell was rung inside the tank. To call this a proof that Marconi waves pass through metal is not conclusive to the scientific understanding. Lodge has long ago shown that Hertzian waves penetrate readily through the smallest cracks in a metal casing.

That the Marconi system of telegraphy will find a considerable number of practical applications we have not the slightest doubt, though we do not see any prospect of its replacing present methods for long distances. Our own and foreign governments have long been striving to discover some efficient methods of signalling between ships at sea or between the shore and light-ships, when owing to fog or darkness or other causes, the ordinary methods are not available. In naval warfare, for instance, by means of the Marconi telegraph, communication might be maintained between an admiral and the commanders of his fleet as efficiently as between the commander-in-chief of an army and his officers during a battle on land, and might even to a great extent supersede the aide-de-camp in transmitting orders on the battlefield. Many other applications will, no doubt, be found for this unique and ingenious system. Signor Marconi deserves the greatest credit for ingenuity and perseverance with which he has developed a successful practical application of some of the latest discoveries in electrical science, and we have little doubt that his name will yet be classed with those of Wheatstone, Graham Bell, and others, who have revolutionised commerce and added to the wealth of nations by facilitating the interchange of intelligence.

THE WELLINGTON SERIES ENGINE.

A good deal of attention has lately been given to a new engine which was a subject of study of the late A. M. Wellington, an able American engineer in the branch of railroad location, which, however, is no guarantee that a knowledge of steam engines is possessed by the same mind. Indeed, it is frequent matter of observation that men exceedingly able in one special direction, are as children in other respects. The *Railroad Gazette*, of which journal the inventor was one time editor, dismisses the invention as one that the deceased man's friends would have been well advised to leave alone, as not adding to his reputation, which was too well established in railroad work to require further help. We believe that certain railroads laid out in Mexico by the deceased engineer are masterpieces of engineering, and his book on railroad location is accepted as standard. In the Wellington engine the idea is to work steam at greater efficiency than hitherto obtained. It consists of a number of ordinary engines arranged in series, with their boilers and condensers arranged so as to utilise in one engine the wastes from that higher in the series. Diagrammatically, the general arrangement shows a row of steam engines, each supplied with steam from its boiler on one side, and exhausting to condenser on the other side. The water from the surface condenser is pumped back to the boiler. All the five engines and boilers are duplicates, but the boilers have no separate furnaces. One furnace is placed at the head of the series, and the heat pass from boiler A to B, C, D and E, and the cooling water from condenser, E, passes in the contrary direction up the series to condenser A, the idea being to thoroughly cool the furnace gases and heat the condensing water. The principle of action is to divide the total heat interval equally throughout each member of the series, both of boilers and condensers. The condensers high up the series are comparatively hot. Thus it is supposed that the A boiler temperature may be 434°, and that of the A condenser 278°, corresponding respectively to 355 lbs. and 48 lbs. Similarly in engine, B, these pressures will be 192 lbs. and 21 lbs., and finally, in boiler E, 14 lbs. will exist in the boiler and 28 inches of vacuum in the condenser. The invention proposes to heat the various boilers, which are of very multitubular type, by means of circulating hot liquid from the heater. Thus highly heated water will leave the heater and heat the various boilers in succession. Then comes the cooler, and following this the upward series of surface condensers gradually raising the liquid again to 288°, when it passes to the heater and is raised to 500°, again entering the cooler at 220°, and passing out of this at 50°. It is now only necessary to assume in each of the series boilers some other liquid than water of less specific heat and lower boiling temperature to grasp the whole invention. The engine is a recrudescence of the binary vapour engine, though we believe the heating of the series boilers by liquid instead of by fuel gases is novel, at least in a sense. We do not look to this series engine as containing any future promise. To begin with, we see no reason to expect that the efficiency of transmission of heat in the heater as between the fire and the circulating liquid will exceed that of the best steam boilers, and should it do so, the fact will not stand to the credit of the series principle, but would merely indicate that the design of a new type of boiler was good.

Next, as regards the use of the several boilers and the carrying round of the heat by means of a circulating fluid, the processes which go on in the complicated arrangement do not in any way circumvent natural laws. There is heating of the working body at less than the maximum temperature, and the result, as shown by the familiar equation, $E = \frac{T_1 - T_0}{T_1}$, cannot but be very unfavourable for any one member of the series. The only thermo-dynamic gain that we can see theoretically possible would be found when the lower end of the series was worked with some liquid more volatile than water, which might extend the lower limit of T_0. But granting this possible, it may well be asked, why so great a complication of parts? Why such exposure of surface? All these extra pumps, boilers, &c., mean so much loss. In the initial heater the entering fluid is the measure of the ultimate reduction of furnace gas temperature, and this is given as 288°. This is a high feed temperature, and is obtained by passing the circulating liquid through the condenser of the highest member of the series, by condensing, in fact, under considerable pressure, taking heat from the engine in an exactly parallel manner with the system of feed water heating by live steam from an intermediate receiver in a compound engine. Whatever advantage or economy there may be in this does not belong, therefore, to the series principle. No ringing of the changes on working fluids will alter the mechanical equivalent of the thermal unit. With steam the final temperature in the cylinder is usually about 100°. Yet the condenser may have a temperature as low as 50°; at least, we often have a condensing fluid at 50°. It is not easy on thermo-dynamic lines to see how there can be got any further work out of the heat supplied, than by the use of some low boiling point liquid that will enable us at the finish more closely to approximate the cylinder and the condenser temperatures. Possibly it might be done by finishing the steam cycle at a temperature of 212°, and going on below that with the other liquid. But people who meddle with the low volatile liquids and talk of their low specific heat and so on, usually fail to remember how exceedingly heavy their vapours are.

In connection with this subject we cannot do better than quote Rankine. His words on p. 446 of the "Steam Engine" are: "The same amount of additional energy which is obtained by the addition of the æther engine to the steam engine might also be obtained by continuing the expansion of the steam sufficiently far, ... provided a sufficiently low back track pressure could be insured; but this might require, in some cases, a cylinder so large, as to be more costly than the binary engine." And again: "The binary engine is not more economical than steam engines designed with due regard to economy of fuel; but by the addition of an æther engine, a wasteful steam engine may be converted into an economical binary engine." This is as much as saying that if one has a steam engine too small for its work, it can be made larger, and will be more economical. The Wellington series engine is one way of enlarging an engine with immense addition to its working frictions. Even if a theoretical gain could be shown, it would be dearly purchased with such complicated engines. It would appear that in pursuit of his idea, Mr. Wellington was driven to attempt to devise certain improved forms of boilers and heaters, and if we are to judge from our American contemporaries, not without some success. The result of an honest attempt to effect something may not have been altogether *nil*.

This idea of the late editor of our American contemporary has failed to find favour with other American journals. It is difficult certainly to understand why it should have been published, unless sentiment towards a late colleague impelled the course in deference to his expressed wishes, but "de mortuis nil nisi bonum" can hardly be held good where a question of engineering truth is involved, as is the case in this Wellington series engine.

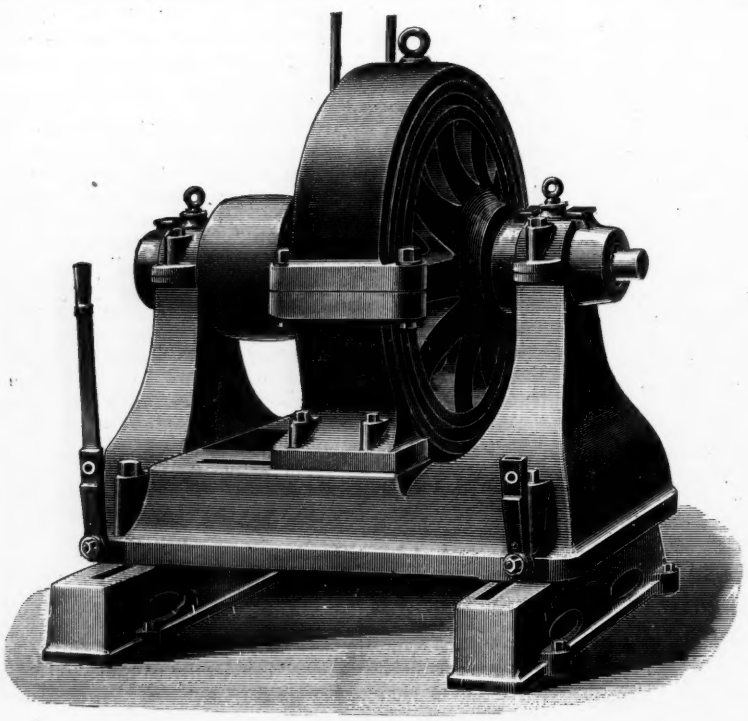
The *Street Railway Review* entirely disagrees with the publishing of the "new process on thermo-dynamics," and points out that the efficiency depends solely upon the temperature of the circulating fluid as it leaves the heater and enters the cooler, and therefore the efficiency of a range 500°—220° (the range given) can only be ·2913. Owing to the need of cooling the circulating fluid below the various condenser temperatures, this reduces the range in each engine of the series so that while nominally each engine should have an efficiency of ·29 its true efficiency is only ·2302 when the number of engines in the series is five. Generally, our contemporary concludes that the efficiency of a series engine would practically not exceed ·218 as against ·323 for a non series under like conditions, and cannot see any reasonable excuse for the use of circulating fluid heated in a boiler which might as well produce steam. This series engine is but another of the many attempts to get to the weather side of nature, a proceeding that seems to call for an immense number of appliances. In this case there is a multiplicity of condensers and engines. No good results ever can accrue in the direct line from such attempts, and we cannot think how so able a man as the late Mr. Wellington could have let himself be drawn after such an *ignis fatuus*.

THE WALKER ALTERNATOR.*

Up to recent date the Walker Company had confined its activity to the manufacture of direct current apparatus, such as dynamos for railway and isolated plant work and to stationary and railway motors. The demands made upon it for arc and alternating apparatus have, however, been such that they could not be ignored, and the result has been the designing of complete systems of both types of the latter apparatus.

This machine is of the "inductor" type, the inductor consisting of a solid iron casting keyed to the rotating shaft. The hub, together with the outwardly projecting arms or spokes with laminated iron tips, forms part of the magnet circuit. There are no windings upon this rotor, the function of which is (1) to provide a path for the magnetic field, and (2) as part of the magnetic circuit, to vary the position of the magnetic flux, relative to the armature coils.

To the interior of the fixed ring shown are secured annular laminations. These armature laminations are furnished with inwardly projecting teeth and support the armature coils. There are twice as many armature coils as there are inductor projections, and at any instant half the



coils lie opposite these, and half opposite the spaces between the inductors. The armature lying external as it does to the inductor, gives room for ample cross section of conducting wire, without infringing on the space necessary for insulation. The coils, themselves, are thoroughly insulated in the process of construction; and again, the sides and bottom of the slots are lined with composite insulation of the best materials before receiving the coils. Thus the insulation between armature windings and frame is of the highest quality, and being upon the stationary portion of the machine, is not exposed to the slow disintegration which deteriorates some varieties of insulation upon revolving armatures.

The inductor and armature together form a discoidal box, the stationary armature ring being the periphery. One side is closed by the projecting arms of the inductor; the other by a casting continuous with the armature ring, and extending radially inwards, leaving only the necessary clearance between it and the inductor hub. Within this annular box, concentric with the shaft and securely bolted to the armature casting, is the coil supplying the excitation necessary for the machine. The magnetic lines generated by this coil, starting from the armature ring, flow inwards along the side of the armature casting, across the air-gap into the inductor hub, out along the inductor arms and through the laminated tips, across the air gap into the armature teeth; the changing position of the inductor arms supply the variation of magnetic flux through the armature coils necessary to produce the required voltage.

The machine is so designed that any repairs, when necessary, can be readily and quickly effected.

* New York *Electrical Engineer*.

SULLIVAN'S METHOD OF DETERMINING THE RELATIVE POSITIONS AND THE TOP AND BOTTOM ENDS OF SEVERAL CABLES IN A TANK.

The above method has lately been very clearly explained by Mr. F. Alex. Taylor in the columns of the *Electrician*, and as it is likely to be of great practical value to cable electricians, we now give our readers an abstract of Mr. Taylor's description, with a few comments which appear to us appropriate.

In the event of the ends of several sections of cable, of similar type and in the same tank, being either marked wrongly or their labels being defaced or detached, it is important to have some certain method of ascertaining the top and bottom end of each section, so that no mistake can be made when splicing one section to another prior to paying out.

Again: In the event of no records being available of the order in which several sections were coiled down into a tank, some reliable means of ascertaining their relative positions in the tank is desirable. These difficulties are cleverly met by Mr. H. W. Sullivan as follows:—

To Determine the Relative Positions of Several Lengths.

1. "Trace all ends in the tank by means of a detector and battery, and mark them in pairs 1—1, 2—2," &c. This would be better done, we think, by a Bridge C R test, so as to obtain at the same time the approximate length of each piece, for reasons mentioned further on.

2. Connect up the top section (the ends of which are always traceable by sending a man down into the tank) in circuit with a small battery (say three cells) and a "make" and "break" key, first looping together in pairs the ends of the other cables (see fig. 1). At the instant of making battery contact so as to complete the circuit of the top section, which may be called the *primary* coil, a more or less momentary current, in the opposite direction, will be induced in the other cables—each acting as a *secondary* coil, but distance being such an important factor in induction, this induced current will be strongest in the cable immediately underneath the top piece, and weakest in that farthest away from it.

In the case of three cables, A, B, and C (see fig. 1), the relative length of the pieces may possibly be such that the inductive effect in C might be greater than in B, *i.e.*, C might be of such length as compared with B as to more than make up for the closer proximity of B to A, thus erroneously indicating A and C to be adjacent lengths. The plan for avoiding possible error of this kind is very simple and ingenious. The induced current is measured under two conditions; firstly with the ends of all the other cables *looped*, and secondly with all ends *free*.

Should the *supposed* second section from the top of the tank be really the one immediately below the top section, the current induced in it will be the same in each case; but

should a length intervene, the effect of looping the intervening length will be to diminish the induced discharge in what was *supposed* to be the second section, the interposed looped cable appearing to act as a partial screen to the inductive energy given out by the top section.

The second cable in the tank having been thus located, it is then in its turn treated as the *primary*, and the third cable is similarly ascertained, and so on. In this way, be the relative lengths what they may, the position of the several cables are determinable with certainty.

With regard to this part of Mr. Sullivan's highly ingenious test, it appears possible that the inductive effect alone might not be quite sufficient in the case of a short section of, say, only one flake, to indicate its position with certainty, unless its approximate length—as shown by its C R, when tracing the ends—be also taken into account, as that would seem necessary, in order to form a rough idea as to how much inductive effect should be expected. This knowledge, in conjunction with Mr. Sullivan's test, would more clearly show whether its position must be above or below another section.

Again: we would suggest that when one of the sections is very short, it would be advisable, after finding its top and bottom end by Mr. Sullivan's test, to connect it in circuit with the longer section above, so that the combined influence of these two sections, acting as the primary circuit, may exert a stronger induction when testing for the next secondary

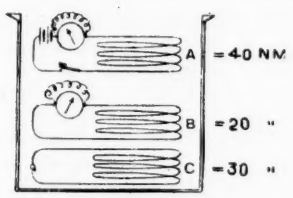


Fig. 1.

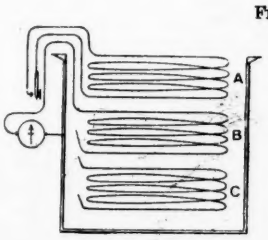


Fig. 2.

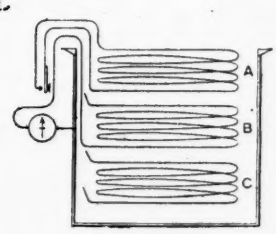


Fig. 3.

section below. This appears additionally important, since the already small influence which a short length, when acting alone, would exert on the section below it, would be weakened by the *counter inductive influence* which it will at the same time be setting up in the section above, which latter would tend to nullify, or at least weaken its effect on the section below. For this reason it seems desirable, irrespective of the length of the section forming the primary circuit, to join it up with all the sections—or at least the next section—above it, before proceeding to test for the next section below; and if any upper section is not so connected up in the primary circuit, it would be better that its ends remain free. For instance, if section B (of very short length) be primary to C, it will develop certain induced currents in C; but being also primary to A, the currents induced in A by B will tend to develop in C currents in the *opposite* direction to those developed by B, and consequently weaken the currents in C. If, on the other hand, A be in circuit with B, the effect on C is increased.

To Identify the Top and Bottom Ends.

First Method.—Join up cable A (as the primary) in circuit with a key and battery and a shunted galvanometer, as in fig. 1, and note the *direction* of the deflection (D), and also observe to which terminal of the galvanometer the *top* end of the cable is connected. The galvanometer may then be removed, leaving only the battery and key in the primary circuit. Next join the two ends of the secondary cable, B, to the same galvanometer, and at the moment of making battery contact again through A, note the direction of the current (*d*) induced in B.

If D and *d* be in *opposite* directions, the ends of cables A and B have been correspondingly joined up to the galvanometer terminals; that is, the top end of each will have been connected to the same terminal; but if D and *d* are in the *same* direction, the ends of B will have been reversed to those of A. B is then made the primary, and the ends of C are similarly identified.

"Both cables being on metallic circuit, a fault existing in the primary or secondary, or even in both cables, would not invalidate the test, provided the inductive effect were still measurable." Mr. Taylor might go further, and say that *one* fault in both would not affect the result at all, nor, indeed, would the test be altogether inoperative even with more than one fault, though of course they would weaken the result according to their nature and position.

In connection with this method, we would suggest that when testing for the top and bottom ends of a cable below a very short section of only one or two flakes, this latter length should be connected up (in the same direction as to coiling) with the section above it, and also that any sections higher up in the tank, and not included in the primary circuit, should be on open circuit, as already recommended, when determining the relative position in the tank of several sections, and for the same reasons.

It in no way detracts from the value of Mr. Sullivan's test—which has the advantage of being applicable to cables coiled in a tank under all conditions—if we call attention to the fact that *at sea*, when the ship is pitching or rolling, the *direction* of the currents induced by the earth's magnetism in a section of cable coiled in the tank, as shown by a galvanometer in circuit, is itself an indication as to which is the top and which the bottom end of that particular section; for if the direction coincides with the induced current in the top section (the top and bottom ends of which are known), under the same condition as to the ship's movement, the ends will be relatively the same. On shore, however, or when the ship happens to be *quite* still in harbour, this method would of course not be applicable.

Second Method.—The above method of identifying ends depends, as pointed out by Mr. Taylor, on the assumption that both the top section and other lengths of cable to be compared with it *are coiled in the same direction*, which is generally the case.

For certain special reasons, however, this may not always be so, and therefore, to meet such altered conditions, Mr. Sullivan has devised a second test, the connections for which are shown in figs. 2 and 3. In describing this test, Mr. Taylor remarks that the test "is based upon the fact that upon charging a cable the distant end does not at once assume the full potential, and any induced current must necessarily follow the same law." "The primary cable is charged as before, and the current induced thereby in the secondary is measured first at one end and then at the other, the distant end being free in each instance." "The two induced charges measured at the top and bottom ends of B will be in opposite directions."

We do not consider that this is the *whole* explanation, since the fact that the top end of section B is free (as shown in fig. 3), would also partly account for that end not developing such strong induced currents as in the case of fig. 2; while at the same time the turns connected with the galvanometer in fig. 3 are more distant, and the currents induced in them consequently weaker. But whatever the exact explanation may be, the test is without doubt a good and useful one, provided that the sections tested consist of several flakes. In cases where there are only one, or even two flakes (say 2 or 3 miles), it does not appear certain that the results would be sufficiently reliable. The longer the cable the more decided would be the *difference* in the galvanometer throws when the galvanometer lead is connected respectively to the top and bottom ends, and therefore the more certain the indication.

The result of an experiment for each test, with three sections in the tank of respectively 40, 20 and 30 knots, is shown in the following table.

Mr. Taylor says that the above "figures seem to show that the shorter the secondary cable, and the lower its resistance, the greater the induced current." "The great strength of the induced current when the secondary cable is looped is

very noticeable, the more so, as it might at first sight appear probable that the iron sheathing wires, which are only very imperfectly insulated by their covering, would act in great measure as a screen, absorbing the inductive energy radiating from the primary, and preventing its reaching the core of the secondary cables in any appreciable degree. That this does not happen is attributable in part, perhaps, to the fact that the iron wires do not form a perfectly closed cylinder around each core." "Another noticeable feature when the secondary cable was looped was the prolonged and sluggish character of the induced charge. In every instance the spot moved steadily up the scale without oscillation, and from 6 to 7 seconds elapsed before it resumed zero, although a marine galvanomer was employed. An equal induced charge of the same sluggish character was noticed on breaking battery contact. This remarkable effect was greatly increased with more heavily armoured cables; the time then occupied by the spot in returning to zero being in one instance as much as 30 seconds, while the induced currents were considerably less than with cables of smaller type or lighter sheathing. On the other hand, when one end of the secondary was freed, the character of the induced charge was quite altered, the throws becoming as sharp as those ordinarily obtained with the 'marine' from a condenser, and being equally difficult to read."

Primary circuit.		Shunt.	Permanent deflection.	Secondary circuit.	Shunt.	Induced throw.	Remarks.
	N.M.	Ohms.		N.M.	Ohms.		
Relative positions of sections.	40	5	85°	30	5	9°	
	40	5	85°	30	20	92°	Ends of middle section [= 20 N.M.] *looped.*
	40	5	85°	30	20	110°	Ends of ditto, *free.*
Identifying ends First method.	40	5	85° right	20	5	30° left	Showing that the top end of each cable had been joined to the same terminal of galvanometer.
	20	5	210°	40	5	22°	
	20	5	210°	30	5	25°	
Second method.	20	5	210°	40	1,000	102° left	Galvanometer lead on bottom end nearest to the primary.
	20	5	210°	40	1,000	80° right	Galvanometer lead on top end farthest from primary.

Damped "marine" galvanometer used in each case. Resistance = 30,000 ohms. Battery, three Leclanché cells.

THE DIRECT READING POTENTIOMETER.

For the exact measurement of current, electromotive force and resistance, the employment of the potentiometer, or fall of potential method, is well known.

In the following description of the direct reading form of instrument, made by Messrs. Elliott Bros., the method of making tests and measurements with it is described and illustrated by means of diagrams.

The measurement of continuous currents consists in determining the exact difference of potential in volts between the terminals of a resistance whose value is known in ohms, and through which the current to be measured is passing, the value being given by Ohm's law, $C = \frac{E}{R}$.

In the above case the difference of potential in question is determined in comparison with the E.M.F. of a standard cell of agreed value.

The measurement of electromotive force consists in its comparison either directly against that of a standard cell, if a value of somewhat the same order is under test, that is to say, not exceeding 1·5 volts. An example given later explains this. Or in the case of high electromotive forces, in applying the pressure to the two ends of a high resistance divided in some known proportion or ratio, so that the current flowing through the total resistance may cause a fall of potential over a fractional part of it to be comparable with the E.M.F. of a standard cell, and this comparison being determined by the potentiometer, the value of the whole E.M.F. under test may be given in terms of this comparison multiplied by the ratio into which the resistance is divided.

In practice, a resistance box is so adjusted, that electromotive forces of 15, 150, 300, and 600 volts, or any intermediate value can be measured by choosing the proper terminals on it.

The measurement of resistance is effected by placing the resistance to be tested in series with a resistance of known value and then passing a constant current through the two of them in series, wires being led from their terminals to the potentiometer; the fall of potential across the unknown one can be determined in terms of the fall across the standard; and the current through the two being the same, the resistance values are exactly proportional to these falls of potential.

In the potentiometer the measurements and comparisons are effected by opposing the electromotive force or potential difference, which, as it will be seen above, is the value dealt with in each case; against the potential difference which exists between two points on a suitably arranged wire, by virtue of a constant current passing continuously through the whole length of this wire. A galvanometer placed as an indicator in the connection between the two opposing electromotive forces serves to show which is the greater, and when no deflection is obtained, it shows that the opposing forces are equal in value and therefore balanced. As it is impracticable to use a standard cell to furnish current uniformly through the divided wire, an accumulator cell is employed, and suitable resistances in the form of rheostats being placed in series with the divided wire, the adjustment of these permits of any fraction of the E.M.F. of the accumulator cell being applied to the divided wire itself.

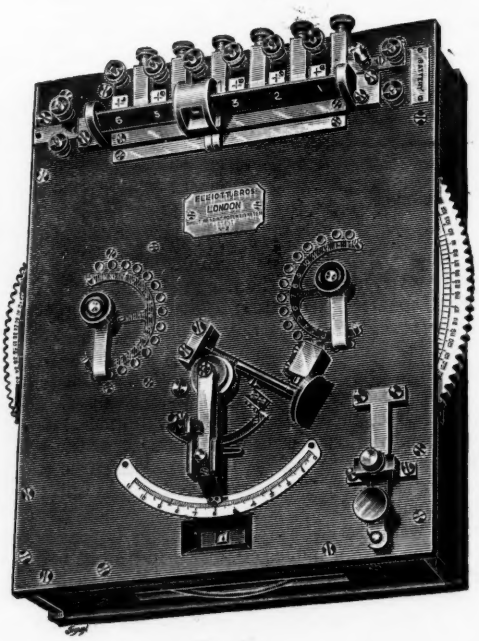


Fig. 1.

The main points arrived at in this method of construction are with the object of enabling the divided wire to be easily and accurately calibrated. Each of 149 sections is about 3 inches in length, and they are all adjusted so as to be absolutely equal in resistance on to the other, the slide portion of the wire, K, M (fig. 2), is extremely short, as can be seen in fig. 1. Inequalities in the drawing of this wire are

compensated for by dividing the scale, over which arm L travels, so that the individual divisions of the divided wire, R R R, are exactly multiples of the divisions on the scale. As an example, the fall of potential over 147 sections of the divided wire is exactly five times that over 28 divisions of this wire, and 14 divisions on the scale.

A reference to the diagram (fig. 2) shows clearly how the arrangement is effected in practice. A, B, are two terminals to which the working battery, *i.e.*, the one accumulator cell, should be attached. At C is a small fuze which serves to protect the slide wire from injury should too high an E.M.F. be applied to A and B by accident.

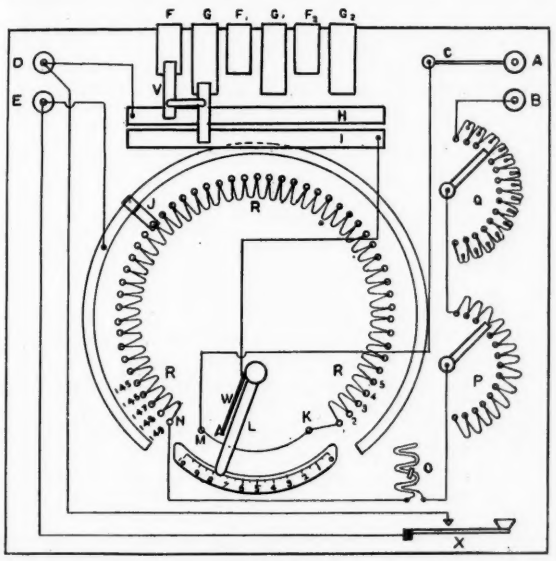


Fig. 2

D, E, are the galvanometer terminals, and across these is connected a short circuit key, X, which in its normal, or free position, keeps the galvanometer short-circuited, and thus protected against violent deflections; a d'Arsonval galvanometer should always be employed in all these tests.

F, G, F_1 G_1, F_2 G_2, &c., are the terminals to which wires leading to the various sources of potential differences to be compared should be attached. A multiple double pole switch, V, permits of the two common bars, H and I being connected to any pair of these terminals at will.

R R R is the divided wire which is laid round in a circular position and divided in 149 parts of equal resistances; small contacts being placed at each of these 149 points. The whole of this part of the divided wire, which of course is the essential part of the whole apparatus, is perfectly protected from mechanical injury by being inside the case.

At one extremity of this wire, N, at the 149th contact it is connected to O, a small fine adjustment rheostat, and so on to the P and Q, two other adjustable rheostats, in series, and so proportioned that the total resistance value of O is rather greater than that of one section P, and that the total value of all the sections of P are slightly greater than that of one section of Q. P, Q and O are not adjusted in any definite values, they serve simply as adjustments; in practice the whole of Q, P, and O are approximately 200 ohms together. The divided wire itself, R, R, R, being about 30 ohms resistance; one end of rheostat Q is joined to terminal, B. The other extremity of the wire, R R R, is taken up through the top of the instrument at K, where it is led round a curved segment, and where the moving contact arm, L, can travel over it; a scale is fixed to the top of the instrument, and a pointer is attached to L, so that when the moving contact is on the stud (K), the pointer attached to the arm, L, stands at zero on the scale. When the arm, L, is moved till the pointer stands at the figure 10, then the moving contact has passed over a length of the divided wire, exactly equal in resistance to any of the other 149 sections between K and N.

A contact, J, can travel round the circle of the divided wire, and make contact with any of the 149 small contacts fixed to it. This contact, J, is attached to a large toothed wheel, the edges of which can be seen in fig. 1 on the right and left of the instrument. This affords a ready means of shifting the position of contact, J, and its position with reference to N and K can be seen through a small window in the front of the instrument, through which a number shows corresponding to the number of the contact on which J lies. A device is provided to cause J to make contact definitely on either one or other of any pair of adjacent contact studs on the divided wire. A wire is led from J to one on the galvanometer terminals, E.

The travelling contact on arm, L, is connected through a small key, W, to the bar of the multiple switch, the other bar, H, being connected to the second galvanometer terminal, D.

The key is provided with a small clamping device, so that it can be kept down if desired, and the galvanometer deflections manipulated with key, X. Care must be taken that no source of high E.M.F. is attached by mistake to terminals, F, G, &c., as in the event of key W being clamped down and switch V being on these terminals, a comparatively powerful current might flow through the galvanometer and the slide wire, probably damaging both. Key W, therefore, should only be clamped down when making a series of tests where there is no chance of a wrong connection having been made outside the instrument.

It will be seen that there exists always between A and B a closed circuit, through which the current furnished by the working battery passes from A through C to M, K, R R R, N, O, P, Q, and so to B. This circuit is of variable resistance owing to the adjustment of rheostats O, P, and Q, but in all cases the whole of the wire, R R R, is in circuit.

Having described the essential portions of the apparatus and their connections among themselves, it may be well to describe the simplest application of the apparatus, that is, the comparison of two resistances.

Having set up a sensitive galvanometer in any convenient position, place the potentiometer on a steady table, and carry wires from the galvanometer terminals to terminals D and E on the instrument, then join two wires coming from a single accumulator cell to A and B, taking care to keep the polarity right as marked on the instrument.

Suppose it is required to obtain the exact value of a resistance which is known to be nearly 1 ohm, and that this resistance is capable of carrying 1 ampere of current without heating; then connect this resistance R x (fig. 3) in

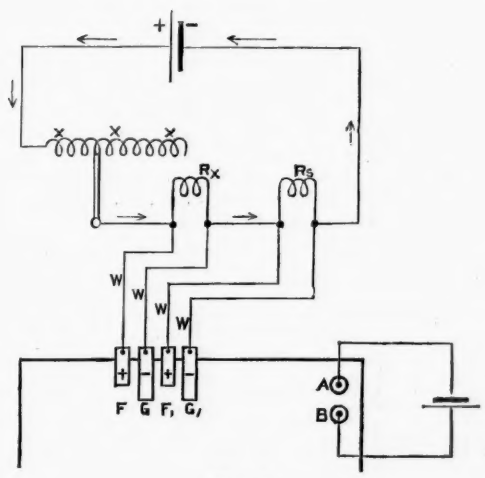


Fig. 3.

series with a suitable resistance whose value is known, R, S, and across the two in series join a large accumulator cell. If 1 ampere should be too great a current to put through R x and R s, then put an adjustable resistance X X X in series with R x and R s, and adjust X X X till the current through the circuit has a convenient value.

It should be borne in mind that the greater the fall of potential obtained, the greater the degree of accuracy in making the test, as a larger value is being dealt with, and therefore a small percentage of this becomes a very small value indeed.

Having arranged the resistances, join their terminals to F, G, F_1, G_1, as shown, taking care to keep the polarities symmetrical in all cases.

The resistances of the connecting wires, W W W W, between the instrument and R x, and R s, are of no consequence whatever, as the whole method is one of balancing opposing forces, and no currents will flow through these connecting wires W W W W; neither is the resistance of the wires forming part of the circuit joining R x and R s together and to the rheostat X X X and the battery, of any consequence, except inasmuch as it varies the total amount of current in the circuit, and hence the *amount* of fall of potential dealt with, but it must affect both R s and R x equally.

A, B being joined to the working battery and current flowing through R s and R x, all is ready to balance up and make a test.

For simplicity's sake, assume R s to be 1 ohm, and that the current be roughly 1 ampere through it, then the fall of potential across it will be about 1 volt, now this is practically equal to one-half of the E.M.F. of the working battery attached to A B, so that for a balance to be obtained, J, (fig. 2) must be in such a position that the fall of E.M.F. on each side of it is about equal.

If R s (fig. 3) has a value of 1, then it is certainly convenient to set J (fig. 2) so that the figure 100 appears at the window, and to put L so that its pointer is at zero. L is of course only a fine adjustment, and may be left out of consideration altogether if a rough test only is wanted.

Having set the figure 100 at the window and the multiple switch V so that it is in connection with the terminals F G, to which are attached the wires leading to the terminals of R s, the rheostat, Q, (fig. 2), should be adjusted till, on closing key W and pressing down key X, the galvanometer deflection is reduced as small as possible, then rheostat P should be brought into operation to still further effect a balance, and finally a complete balance can be obtained by adjusting the rheostat O. It is obvious that for this adjustment to be of any use, that the currents through the two circuits be constant throughout the tests, it is therefore always advisable to connect on the accumulator cells shortly before beginning to test so that the current values may have time to settle down.

Having obtained a balance with 100 at the window and the arm, L, at zero, release key, W, and move the multiple switch till it is in contact with F_1, G_1, and R x (fig. 3); then depress key W. Should the galvanometer move very slightly, then move arm L round by hand, or by means of the fine adjustment screw, until the galvanometer stands at zero once more; suppose a balance is reached with L at 1·3, then the value of R x = 1·0013 in terms of R s.

Should moving L to the left, however, increase the galvanometer deflection, then the large toothed wheel must be moved till 99 is at the window, or even further, and the final balance obtained by adjusting the position of L. Suppose the figure 97 shows at the window and L stands at 8·4, then the value of R x in terms of R s = ·9784; or, assuming R s to be 1 ohm, then R x = ·9784 ohms.

It will thus be seen that the readings can be very quickly taken with great accuracy, as in practice a further figure than those given can easily be read.

It is advisable always to move the multiple switch back to F, G, and take a reading on R s with 100 at the window and L at zero, just to see that no alteration has taken place in the balance at this point owing to variation in either of the currents, due to heating of wires, bad connections, or the like. In practice it is easy to make a large number of tests without any appreciable alteration in the original balance taking place.

Any alteration must, of course, be compensated for by a small movement of rheostat O, or, if necessary, by rheostat P as well.

The foregoing describes how a resistance can be measured when its value is very near to that of the standard with which it is compared; but suppose R x is only about one-third of an ohm; then keeping the original conditions of balance, the figure 33 must appear at the window, and the arm, L, stand about 3 for R x to balance; in other words, the instrument becomes direct reading in terms of the standard.

Suppose R x is about 1·4 ohm, then 140 must appear at the window, and so on.

Suppose R x is 1·7 ohm, or, in fact, anything over 1·5, which, of course, is the highest figure obtainable at the window and arm, L, then either a 2 ohm standard must replace the 1 ohm standard at R s, or if R s remain 1 ohm, it must be balanced lower down on the potentiometer, say 50, by interposing greater resistances in the rheostats, P, Q and O (fig. 2). Then assuming a balance on R s with 50 at the window and arm, L, at zero, if R x is 1·710 ohms, it will balance with 85 at the window, and arm, L, at 5 on the scale.

From the diagram (fig. 2) it will be seen that resistance can always be added outside the instrument itself, between terminal B and the working battery should rheostats P and Q not afford range enough in some special cases.

Now suppose that in the case of R s we have a resistance which, instead of being exactly 1 ohm, has a value of ·9998, and it is desired to get the value of R x in ohms. All that is necessary is to balance R s in the first instance with 99 at the window, and arm L at 9·8; then evidently the resistance which would balance with 100 at the window and arm, L, at zero would be accurately 1 ohm.

The above describes how single ohms can be compared, it is quite obvious that half a dozen 1 ohm resistances could be joined in series, a suitable increase in the battery available to pass current through them being made, and wires being joined to the other available terminals, F_2, G_2, &c.

A test can be run round the set and any desired one chosen as a standard, and their values all taken out.

For measurement of lower values, say, ·001 ohm, the method described above is followed out exactly, only naturally when R s and R x (fig. 3) are about ·001, a much larger current must be employed through them, and special care taken to ensure solid and reliable connections for the main current, and suitably disposed "potential" points for the connection of wires leading to F, G, &c.

Suppose R s to have a value of ·001 ohm, and to have 500 amperes through it, then the fall of potential across it will be ½ volt.

Balance with rheostats P, Q and O, as before, with 100 at the window, and arm, L, at zero; then, when R x is connected on, if balance is obtained with 99 at the window, and arm, L, at 8·1, then the value of R x is equal to ·0009981 ohm.

This measurement being made with accuracy quite equal to that of the tests of single ohms, as it is only the falls of

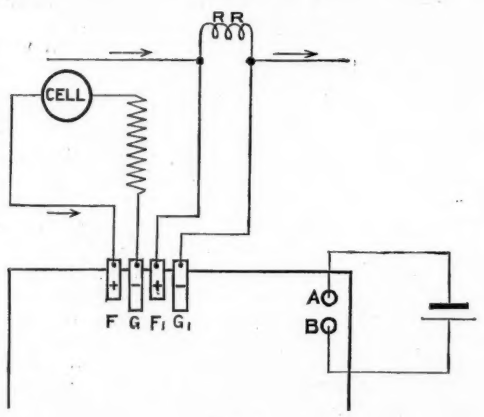


Fig. 4.

potential which are compared after all, not the resistances themselves; but the resistances are proportional to these falls, inasmuch as the resistances being joined in series the same current passes through both.

Current Measurements.—The method for these tests is very similar, now it is assumed that the value of the resistance through which our current passes is known; and we are to compare the fall of potential obtained across it with some standard E.M.F.

To do this a standard fall of potential must be arranged on the divided wire.

In fig. 4 the working battery is joined to A and B just the same as before, a standard cell is joined up to F G through a high resistance to prevent any appreciable current being taken off the cell. The current to be measured passes through the resistance standard R R.

First, if the E.M.F. of the standard cell be assumed, at the temperature at the time of test at 1·434 volts, then let the figures 143 be set at the window and arm L point to 4 on the scale. Rheostats P, Q, and O must be manipulated till a balance is obtained on depressing key W, when the multiple switch, V, is on the terminals, F G, then each movement of the toothed wheel means ·01 volt, and the movement of arm L from 1 to 2, or 2 to 3 on the scale means ·001 volt.

The fall of potential across resistance, R R, can be determined in a moment. Suppose the current is about 500 amperes and we know the value of R R to be ·001 ohm exactly, then if a balance is obtained with the multiple switch V on F G, with 50 at the window and arm L at 1 65 on the scale, then the current through R R is equal to 501 65 amperes.

Suppose again that the current is about 1 ampere and that we know the value of R R to be 1 ohm exactly. Then, the potentiometer being balanced as before, we may find when the multiple switch, V, is put at F, G, that a balance is obtained with 101 at the window and the arm, L, at 3·65 on the scale, the current through R R is then equal to 1·01365.

E.M.F. Measurements.—Fig. 5 illustrates the connections. The working battery is connected to A B as usual, the standard cell and resistance to F, G.

The small separate resistance box is employed, the two terminals marked "potentiometer" being connected to F_1, G_1, wires attached to the source of E.M.F. to be measured being

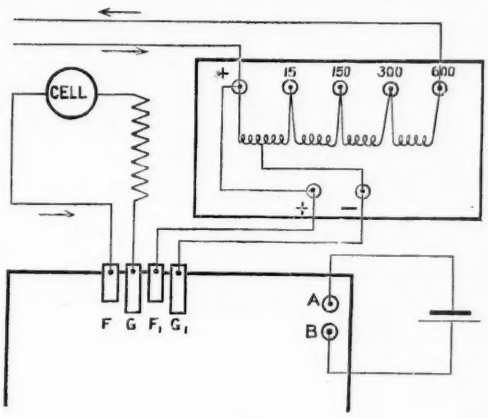


Fig. 5.

connected to terminals on this box according to the various ranges used. The terminals marked "potentiometer" have between them a small fractional part of the whole resistance in the box.

Setting the figure 143 at the window, and arm L at 4 on the scale as before, when a balance is obtained with the multiple switch on the standard cell at F, G, then each movement of the toothed wheel means ·01 volt, and ·0001 corresponds to the small whole divisions on the scale.

Suppose an E.M.F. of about 100 volts is to be measured, the positive wire should be joined to the terminal marked + on the separate resistance box, and the other to the terminal marked 150. Then, having balanced as above, the instrument is direct reading in volts; that is to say, if a balance is obtained with 101 at the window and arm, L, at 5·3 on the scale, then the E.M.F. under test equals 101·53 volts. For readings using the + to 15 terminals on the separate resistance box, the readings must be divided by 10; if using terminals + to 300, readings must be multiplied by 2; if using + to 600, multiply by 4.

Supposing it is desired to determine exactly an E.M.F. of about 2·2 volts. Obviously if the standard cell is balanced with 143 at the window, and 4 on the scale, the range of the potentiometer is insufficient to compare this directly; if the terminals + to 15 on the separate resistance box are used, then the E.M.F. of 2 2 volts would balance with figure showing at the window. For great accuracy the following method may be adopted:—

Connect two accumulator cells in series to A, B, then with switch, V (fig. 2), on F, G, corresponding to the terminals of the standard cell, adjust P, Q and O so that a balance is obtained with 71 at the window, and arm, L, at 7 on the scale $\left(\frac{1.434}{2} = ·717\right)$ assuming that the E.M.F. of the standard is taken at 1·434 volts at the working temperature, then let wires be brought from the source of E.M.F. to be tested to terminals, F, G, then if a balance is obtained on moving the multiple switch to F_1, G_1, when 111 at the window and arm, L, at 4 on the scale, then the value of the E.M.F. under test = 1,114 × 2 = 2·228 volts. That is to say, with the standard balanced at the position corresponding to half its value, all readings at the wind and scale must be double, to obtain correct values in volts.

This process can be carried further, but not more than 6 volts should ever be applied to A, B.

TUITION IN TRACTION.

It is, we regret to think, too often the case, that really excellent and well-timed remarks upon developments in any particular branch of electrical work are only made before a limited but appreciative audience which thoroughly understands the points emphasised, and this applies most especially just now to electric traction.

The most sapient sentences are not poured into the ears of tramway directors or town councillors, but are heard at the Institution of Electrical Engineers, or at still more informal meetings, and perhaps even in Parliamentary Committee Rooms, though in the latter case, as ill luck will have it, the grain of common sense and sound experience is very often hid by a cloud of forensic chaff.

How many local authorities, for instance, have heard of, far less actually perused, the remarks made before the Bray Commissioners a month or two ago by Mr. Thomas Nevins, and briefly reported by us in our issue of April 9th last. Probably a great many of his hearers thought that his little speech was a fine specimen of trans-Atlantic bluff, yet there was absolutely nothing there stated but veritable fact, which every local authority in the Kingdom might learn with advantage.

The same remarks apply to an address delivered before the New York Electrical Society a few weeks ago by Mr. E. E. Higgins: the substance of what he said is admirable, and must have been greatly appreciated. But it might have done more good as a presidential address to the people of the United States in regard to one not unimportant branch of the country's industry. At any rate, it would then have had a well deserved publicity, which is all we can help to give it, in the hope that the non-technical press will take the points, and drive them home in the quarters that they can best reach.

After a brief sketch of the enormous developments in electric traction during the past nine years—no less than 85 per cent. of the 15,000 miles of street tramway in the United States being operated at present by electricity, as compared with 8 per cent. by horses, and 4 per cent. by cable—Mr. Higgins made a most important point of tramway companies' powers and privileges in regard to their leases or charters—*franchises*, the Americans call them. At first these were bestowed freely, and almost in perpetuity; but of late the municipalities have gone to the opposite extreme in some cases, and insisted on quite short periods of lease, as for instance in Illinois, where the wholly inadequate period of 15 years is now laid down.

The average life of a franchise is from 30 to 40 years—a term regarded as much too short for the adequate prosperity of street railroads. The same average time prevails upon the Continent of Europe, by the way, and the United Kingdom is almost alone in insisting upon such wholly ridiculous periods as 21 years or less.

The fact of the matter is that when the English Tramways Act of 1870 was passed, the municipalities had suffered very considerably at the hands of gas and water companies, originally formed with practically perpetual rights, and now to be bought out at exorbitant profits. Hence the provision in the 1870 Bill of the famous Clause 43, empowering local authorities to buy up the tramways in their districts at the "then value," which meant that of scrap iron, in effect. The tramway companies (largely in the hands of promoters

who kept plenty of "water" for the stock), made no objection in their blithesome ignorance, considering that 21 years would be ample for repaying capital and affording good dividends on lines worked by horses!

It is not a long enough period for electric lines, where the percentage of expenditure to receipts may usually be brought down to 60 or less; the matter was therefore almost hopeless with horse lines, and there are probably not half a dozen systems now working that could be taken over by the local authority without serious loss to the shareholders.

The same mistake was made in the matter of electric lighting; a limit of 21 years, as first fixed by the 1882 Act, simply led to stagnation in the industry, and not until this mischievous legislation was repealed, and a period of 42 years allowed, was there to be seen any progress in electric lighting on a large scale.

Unless, therefore, it be clearly understood that electric tramways may be built and worked under the Light Railways Act, without the vexatious restrictions thought advisable in 1870, we shall not see the great developments taking place in their construction which are desirable and necessary.

It is, however, more than likely that both in the United States, and in this country, the authorities will see clearly that it is no use grabbing the life out of tramway enterprise in this way. If tramway companies are to exist at all (and in many cases they are a necessity, for instance on systems passing through several districts where a joint committee would have to work the lines if they belonged to the respective local authorities) they must be allowed freedom to live and make a modest 5 per cent. They cannot do this with satisfaction to the public, and pay off their capital by means of a sinking fund, with a life of only 21 years; and the sooner municipalities realise this the better.

Mr. Higgins's next point dealt with the question of fares; and in this respect he quite rightly, we think, advocates the American system of uniform fares rather than the custom of a distance tariff which we employ so largely in Europe. The latter method he thinks has a tendency to keep the working classes from living right outside the towns and cities. If a uniform fare gives satisfaction in the States, where the rides are so much longer, he thinks the same system ought to do so here also on short lengths.

Of course the difficulty is that the penny stage has obtained in Europe a foothold which would be difficult to dislodge; and a uniform fare of one penny would hardly pay throughout as lines extend into the suburbs for three or four miles, especially if a local authority should insist upon an expensive conduit system being installed.

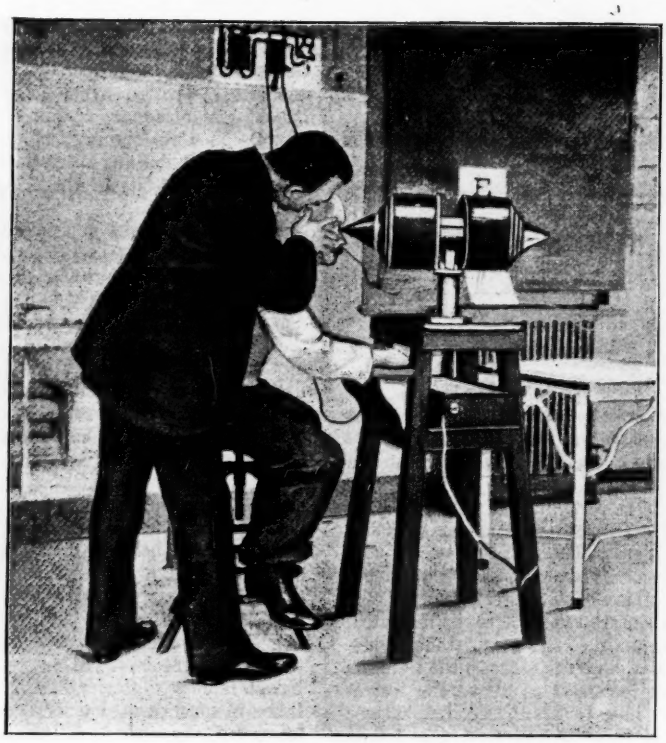
His next remarks concern the question of schedules or regular time tables, and are very apposite. "The moment you begin to talk of schedules for street railways," he says, "people begin to walk. If they know they can get a car by waiting five minutes, they will do so, otherwise they will probably walk so far that when the car overtakes them, they will not consider it worth while to ride the rest of the distance." These are sentences that every one concerned in the management of tramways should have pasted in his hat.

A few sentences anent transfers, the difficulties of properly and economically working them, lead up then to Mr. Higgins's main subject—the question of meeting the successful competition of electric inter-urban and suburban lines by equipping the corresponding steam railways for electric traction. This is a subject with which we shall deal elsewhere in connection with some recent developments in third rail working on the New York, Newhaven & Hartford line; suffice it to say that Mr. Higgins considers the open field in this direction to be enormous. Greater speeds are possible than can be reached on the street lines, whilst stations at frequent and convenient places give such systems almost the same elasticity as a tram line.

We commend Mr. Higgins's address—not so much to electrical engineers, for they know it already, or ought to—but rather to those non-technical men who are called upon to deal with tramway matters, as directors of a company or public representatives upon a local body.

LARGE ELECTRO-MAGNET FOR EYE SURGERY.

One useful application of the electro-magnet is in locating or extracting particles of iron or steel lodged in the eye. The simplicity and utility of this plan are obvious, and it is found to be of real value to surgeons. The illustration which, along with the description we have reproduced from the *Western Electrician*, shows the apparatus installed in one of the operating rooms of the New York Eye and Ear Infirmary to take advantage of the attractive power of the electro-magnet. The soft iron core of the large magnet here used is about 2 feet long and 3 inches in diameter, pointed at each end, as shown. The winding is disposed on spools in the manner indicated in the picture and is supplied with current from the house mains. The whole magnet rests on a stand and is arranged to turn easily at the touch of a hand. The practical value of the magnetic appliances is described in the *Illustrated American*, from which the picture is reproduced, by George B. Waldron:—



Large Electro-Magnet for Eye Surgery.

Suppose, as often happens, a worker in iron or steel is struck in the eye by a fine splinter of metal from a machine. The intense pain which follows is as nothing in comparison with the imminent danger of losing the eye. The case requires the attention of the most skilful specialist. So the sufferer is taken at once to the hospital.

The first thing to do is to locate the piece of metal. The instrument used is a small needle highly magnetised. If the splinter is on the surface of the eye it will cling to this needle and can be easily removed.

But it may have been hurled with such force as to have

become imbedded in the eye itself. The white portion of the eye which surrounds the iris or coloured ring is composed of tough muscles, which can be penetrated with only the greatest difficulty. If the iron or steel particle becomes imbedded in this muscular tissue it will not yield to the magnetic needle.

Now comes the use of the large magnet. This instrument has a drawing force of 16 lbs. As the eye of the patient is pressed toward its point the subtle magnetic power begins to draw upon the splinter. The metal, struggling for release, bulges the eye from the socket. If not too deeply imbedded the splinter will yield to the force and, leaving the eye, become attached to the point of the magnet.

But, as only too often occurs, the metal may strike with such force as to perforate the coating and drop down into the cavity of the eyeball. Especially is this the case when it passes through the iris or the pupil. One instance was mentioned by the attendants at the hospital of a splinter which passed entirely through the eye and lodged in the coating on the other side of the ball.

Applied to the eye, the big magnet will reveal with accuracy to the skilled sight of the physician the position of the troublesome particle. Knowing this, he can remove it by an operation. Only in the most desperate cases need loss of sight follow.

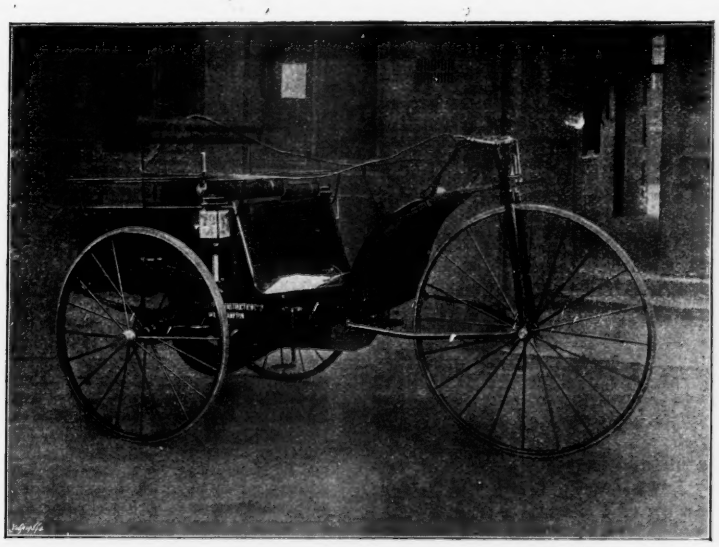
THE MOTOR CAR FIASCO.

THE motor car trial inaugurated by our contemporary, the *Engineer*, has come to a most lame and impotent conclusion. Out of some 70 entries, only five turned up. The *fiasco* is covered by a ponderous leader in the well known style of the *Engineer*. Seeing that the 1,100 guineas prize remains in their hands, evidently the position is a litttle awkward, and though we don't think any really ideal car was sent in, the general public will feel that such as were might have been allowed to make the run to Birmingham. They will not be satisfied at their summary condemnation. The Prince of Wales's Hospital Fund benefits by the amount of the 72 entrance guineas, but the 1,100 guineas remain—perhaps still to be competed for. Our contemporary has made in the aforesaid ponderous leader a few good points. First, that it is obvious that the motor car industry of this country is practically non-existent. No one will gainsay this so long as they admit that vehicles using petroleum spirit were properly excluded. The exclusion of this class from the competition practically assured the *status quo* of the 1,100 guineas. At the present time the spirit engine is the only motor that has effected much. True it smells, it can only creep up hills, it vibrates, it is noisy, and so on, but it is a success, and it was ruled out, and being so negatives the claim made by the *Engineer* that the best England can do at present was to be seen at the trial.

This may be true, but it is a *non sequitur* all the same. Similarly, the claim that because Coventry sent nothing it had nothing to send, is equally valueless. Had a reasonable chance been offered to cars of Daimler or similar types, we could then have properly appreciated their absence from the trial. Why is so laboured an attempt made to cover and excuse this ruling out? There has been much fooling done by promoters of motor car companies, and big claims have been made. These claims can still be made, and unscrupulous promoters can point out they have been ruled out. The *Engineer* has played into the hands of these people.

Unfortunately, the electric car, though it ran exceedingly well, is limited to runs of 20 miles between charging stations. The steam van, too, is well spoken of, but the driver has seven handles to manipulate, and a second man seems to be necessary to steer. Its fire roars, frequently smoke is emitted, and when starting clouds of steam are given off. We are not favoured with reasons why no prize was allotted to any vehicle. It would be satisfactory to have these reasons. We need not be suspected of contempt of court in asking for its reasons. Our contemporary accepts the court's decision without a murmur, and claims the judges names as all-sufficient in themselves. All the same, the reasons of so august a tribunal should be the more instructive to less elevated mortals.

At the same time, while not agreeing with the *Engineer's* methods or mode of reasoning, we may agree that the motor car is yet to be made. Not merely as a machine is it far from perfect, but as a carriage it is equally imperfect. Tied down to the exterior appearance of the horse-drawn vehicle, and apparently, also afflicted with the fear of the older locomotive men that drove them to adopt low centres of gravity, the motor car men of to-day put their passengers as near the road as possible. Why cannot they place them well above the ground with a clear view over the hedge rather than into the ditch, and thereby find machinery room below him, so escaping at once from the thraldom of the old design, and the necessity of cramping their machinery into the narrowest possible space. What, however, do we find? In the first place, of the six cars sent in, one was a steam van; one an electric three-wheeled cart, somewhat of the type of an American buggy, while the remainder were naphtha or petroleum oil vehicles.



Of these, Mr. Cornell's car, as illustrated in the *Engineer*, is a low four-wheeled vehicle with bicycle wheels and India-rubber tyres. There is a low front board, and the machinery is in the body of the vehicle, which is very low. Mr. Holroyd Smith has put in a car, and very properly too, for was he not early in the field with electric traction. This time, however, it is apparently a naphtha car; but no description is vouchsafed of a vehicle which appears to have been designed for strength rather than appearance. This car was not a starter, nor is there anything beyond its picture in the matter published to show any connection with the affair.

The Roots and Venables car is of the heavy oil type with a tubular frame, bicycle wheels, and the usual but improved appearance of the naphtha car with something original about it, and high perched seats. Its motor runs at 510 revolutions, has two cylinders, but only develops 3·2 B.H.P. It is chain geared through countershaft. This firm send also a petrocycle, also fairly original, and of moderate appearance,

The cooling water was carried round the fly-wheel in a tube, so as to benefit by the air current set up by the wheel.

The Yeovil motor car is also a heavy oil car, suitable for ordinary lamp oils, with alternately firing two cylinders, intermediate shaft and chain gear, with two speeds of 10 and 4 miles per hour. The general appearance of this car is that of an ordinary four-wheeled carriage, *minus* the horse. The Bushbury electric car may have run well, but its style was bad, the third wheel in front for steering being very awkward looking, and the design generally heavy and unsuitable. Reins are used in guiding; this is bad practice, and a too slavish following of the horse idea for any hope to be entertained of originality from the engineers.

The controlling switch has four positions, namely off: 40 cells in series in motor circuit; 40 cells in series with a resistance in parallel with the magnets, and 40 cells in two parallels of 20 each.

The motor can be set to generate current when running down hill, as a check on the speed. The *Engineer* supplies the following particulars:—

The motor is carried by a frame, articulated at one end to the road axle-bearing cases and at the other end slung by an elastic attachment to the under side of the footboard. In working, the distance between the motor and road axles is fixed, but can be adjusted to compensate for wear in the chain. The driving wheels are 39 inches diameter, and the steering wheel 45 inches, of steel throughout, with solid rubber tires and ball bearings. The sprocket-wheel is 20½ inches diameter; the chain is ½ inch pitch, and has a breaking strain of over 400 lbs. About three-fourths of the weight is carried on ordinary elliptical carriage springs, resting on the bearings of the driving axle, the rest of the weight is carried by the front wheel. The gauge is 4 feet 6 inches, and wheel base 5 feet 6 inches. All the working parts are boxed in, but are easily accessible from above. The motor bearings receive continuous lubrication from an endless chain dipping into a reservoir of oil. The motor is series-wound, and has a slotted armature, drum-wound, with Eickemeyer coils, and carbon brushes are used. The magnet is two-pole, wound with a single coil of square wire. The commercial efficiency is about 80 per cent., with 80 volts 10 amperes, at 700 revolutions per minute, this output approximately corresponding to a speed of 10 miles an hour.

The accumulators are of the Faure-King type, manufactured by the Electrical Power Storage Company, Limited. There are four boxes, each containing ten cells, the total weight being about 5 cwt. Each cell consists of two half plate negatives and one positive. The rated capacity is 40 ampere hours at a discharge rate of 5 amperes, or about 28 ampere hours at a discharge rate of 15 amperes. The accumulators are carried in the body of the car, and terminals are provided for charging them in place, for which current at 100 volts is required. They are completely discharged when the volts drop to 74, and then require about seven hours to re-charge. The depth of the boxes and cells is such that violent jolting does not cause the acid to be spilt."

It thus appears that to run 20 miles with a couple of passengers the car must carry 5 cwts. of cells, but the total weight of car is 13½ cwts., so that a car of 1 ton might run 40 miles. Probably this is the best possible result that can at present be got from accumulators. The *Engineer* speaks most highly of the steam van of the Liquid Fuel Engineering Company. This is a business-like vehicle, using steam generated in a water-tube boiler, the fuel being petroleum. The application of this boiler and furnace to road locomotion is a new departure on the part of the firm.

About two-thirds of the length of the van inside is available for passengers or goods. Under the floor is placed a pair of horizontal tandem compound engines, so small, as to resemble models, and beautifully made. When running at 625 revolutions per minute, with a pressure of 250 lbs., they give about 12 brake horse-power. The crank shaft is geared about 2 to 1 to a countershaft, which is geared about 4 to 1 on the road wheels. Thus the carriage wheels make 1 revolution for about 8¼ revolutions of the crankshaft. Under the driver's seat, which extends across the front of the van, is a box, the seat forming the lid. In the box are two horizontal plunger feed pumps, driven by an inclined shaft and bevel gear from the first countershaft. One of these pumps is spare. There is also in the box a little horizontal double-acting steam donkey pump, for feeding the boiler when the van is standing. The driving wheels are turned by toothed wheels secured to the wood spokes, and enclosed in cases, so made, that it is claimed that no dirt can get in. The engines and all the gearing is readily accessible.

The boiler is not unlike a Thorneycroft boiler with solid drawn copper tubes. It is placed across the car behind the driver's seat.

The steam drum is of Elmore copper. The oil is gasefied by its own combustion, and oil is supplied to the gasefier by air pressure. With complete combustion all the steam was made that the engines could use. Despite all this the car was not deemed to be even worthy of making its run to Birmingham and back, but all the same it set off on the Tuesday to do so, and the *Engineer* admits that it made this trip at an average of 8 miles an hour. The Roots petro-car also set off and had reached St. Albans at 4.30. It is to be regretted that a full explanation is not given as to this deplorable fiasco and the summary conclusion of the judicial trio.

SIGNALLING THROUGH SPACE WITHOUT WIRES.*

By W. H. PREECE, C.B., F.R.S.

Science has conferred one great benefit on mankind. It has supplied us with a new sense. We can now see the invisible, hear the inaudible, and feel the intangible. We know that the universe is filled with a homogeneous continuous elastic medium which transmits heat, light, electricity, and other forms of energy from one point of space to another without loss. The discovery of the real existence of this "ether" is one of the great scientific events of the Victorian era. Its character and mechanism are not yet known by us. All attempts to "invent" a perfect ether have proved beyond the mental powers of the highest intellects. We can only say with Lord Salisbury that the ether is the nominative case to the verb "to undulate." We must be content with a knowledge of the fact that it was created in the beginning for the transmission of energy in all its forms, that it transmits these energies in definite waves and with a known velocity, that it is perfect of its kind, but that it still remains as inscrutable as gravity or life itself.

Any disturbance of the ether must originate with some disturbance of matter. An explosion, cyclone, or vibratory motion may occur in the photosphere of the sun. A disturbance or wave is impressed on the ether. It is propagated in straight lines through space. It falls on Jupiter, Venus, the Earth, and every other planet met with in its course, and any machine, human or mechanical, capable of responding to its undulations indicates its presence. Thus the eye supplies the sensation of light, the skin is sensitive to heat, the galvanometer indicates electricity, the magnetometer indicates disturbances in the earth's magnetic field. One of the greatest scientific achievements of our generation is the magnificent generalisation of Clerk-Maxwell that all these disturbances are of precisely the same kind, and that they differ only in degree. Light is an electro-magnetic phenomenon, and electricity in its progress through space follows the laws of optics. Hertz proved this experimentally, and few of us who heard it will forget the admirable lecture on "The Work of Hertz" given in this hall by Prof. Oliver Lodge three years ago.

By the kindness of Prof. Silvanus Thompson I am able to illustrate wave transmission by a very beautiful apparatus devised by him. At one end we have the *transmitter* or oscillator, which is a heavy suspended mass to which a blow or impulse is given, and which in consequence vibrates a given number of times per minute. At the other end is the *receiver*, or resonator, timed to vibrate to the same period. Connecting the two together is a row of leaden balls suspended so that each ball gives a portion of its energy at each oscillation to the next in the series. Each ball vibrates at right angles to or athwart the line of propagation of the wave, and as they vibrate in different phases, you will see that a wave is transmitted from the transmitter to the receiver. The receiver takes up these vibrations and responds in sympathy with the transmitter. Here we have a visible illustration of that which is absolutely invisible. The wave you see differs from a wave of light or of electricity only in its length or in its frequency. Electro-magnetic waves vary from units per second in long submarine cables to millions per second when excited by Hertz's method. Light waves vary per second between 400 billions in the red to 800 billions in the violet, and electric waves differ from them in no other respect. They are reflected, refracted and polarised, they are subject to interference, and they move through the ether in straight lines with the same velocity, viz., 186,400 miles per second—a number easily recalled when we remember that it was in the year 1864 that Maxwell made his famous discovery of the identity of light and electric waves.

* Friday evening discourse delivered before the Royal Institution June 4th, 1897.

Electric waves, however, differ from light waves in this, that we have also to regard the direction at right angles to the line of propagation of the wave. The model gives an illustration of that which happens along a *line of electric force*, the other line of motion I speak of is a circle around the point of disturbance, and these lines are called *lines of magnetic force*. The animal eye is tuned to one series of waves, the "electric eye," as Lord Kelvin called Hertz's resonator, to another. If electric waves could be reduced in length to the forty-thousandth of an inch, we should see them as colours.

One more definition and our ground is cleared. When electricity is found stored up in a potential state in the molecules of a dielectric like air, glass or gutta-percha, the molecules are strained, it is called a *charge*, and it establishes in its neighbourhood *an electric field*. When it is active, or in its kinetic state in a circuit, it is called a *current*. It is found in both states, kinetic and potential, when a current is maintained in a conductor. The surrounding neighbourhood is then found in a state of stress, forming what is called a *magnetic field*.

In the first case the charges can be made to rise and fall, and to surge to and fro with rhythmic regularity, exciting electric waves along each line of electric force, and in the second case the currents can rise or alternate in direction with the same regularity, and originate electro-magnetic waves whose wave fronts are propagated in the same direction.

The first is the method of Hertz, which has recently been turned to practical account by Mr. Marconi, and the second is the method which I have been applying, and which, for historical reasons, I will describe to you first.

In 1884 messages sent through insulated wires buried in iron pipes in the streets of London were read upon telephone circuits erected on poles above the housetops, 80 feet away. Ordinary telegraph circuits were found in 1885 to produce disturbances 2,000 feet away. Distinct speech by telephone was carried on through one quarter of a mile, a distance that was increased to 1¼ mile at a later date. Careful experiments were made in 1886 and 1887 to prove that these effects were due to pure electro-magnetic waves, and were entirely free from any earth conduction. In 1892 distinct messages were sent across a portion of the Bristol Channel between Penarth and Flat Holm, a distance of 3·3 miles.

Early in 1895 the cable between Oban and the Isle of Mull broke down, and as no ship was available for repairing and restoring communication, communication was established by utilising parallel wires on each side of the Channel, and transmitting signals across this space by these electro-magnetic waves.

The apparatus (fig. 1) connected to each wire consists of—

(*a*) A rheotome or make and break wheel, causing about 260 undulations per second in the primary wire.
(*b*) An ordinary battery of about 100 Leclanché cells, of the so-called dry and portable form.
(*c*) A Morse telegraph key.
(*d*) A telephone to act as receiver.
(*e*) A switch to start and stop the rheotome.

Good signals depend more on the rapid rise and fall of the primary current than on the amount of energy thrown into vibration. 260 vibrations per second give a pleasant note to the ear, easily read when broken up by the key into dots and dashes.

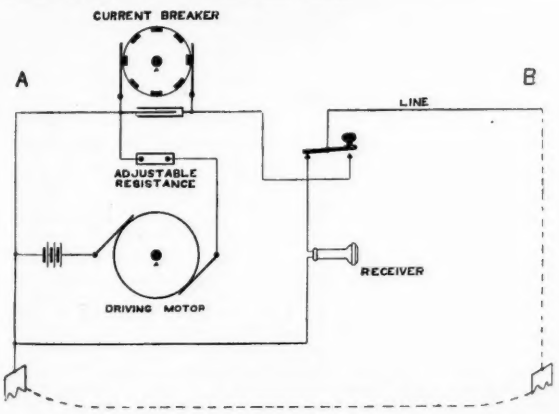


FIG. 1.

In the electro-magnetic system two parallel circuits are established, one on each side of a channel or bank of a river, each circuit becoming successively the primary and secondary of an induction system, according to the direction in which the signals are being sent. Strong alternating or vibrating currents of electricity are transmitted in the first circuit so as to form signals, letters and words in Morse characters. The effects of the rise and fall of these currents are transmitted as electro-magnetic waves through the intervening space, and if the secondary circuit is so situated as to be washed by these ethereal waves, their energy is transformed into secondary currents in the second circuit which can be made to affect a telephone and thus to reproduce the signals. Of course their intensity is much reduced, but still their presence has been detected though five miles of clear space have separated the two circuits.

Such effects have been known scientifically in a laboratory since the days of Faraday and of Henry, but it is only within the last few years that it has been possible to utilise them practically through considerable distances. This has been rendered possible through the introduction of the telephone.

Last year (August, 1896) an effort was made to establish communication with the North Sandhead (Goodwin) light-ship. The apparatus used was manufactured by Messrs. Eversheds & Vignoles, and a most ingenious relay to establish a call was invented by Mr. Evershed. One extremity of the cable was coiled in a ring on the bottom, embracing the whole area over which the light-ship swept while swinging to the tide, and the other end was connected with the shore. The ship was surrounded above the water line with another coil. The two coils were separated by a mean distance of about 200 fathoms, but communication was found to be impracticable. The screening effect of the sea water and the effect of the iron hull of the ship absorbed all the energy of the currents in the coiled cable, and the effects on board, though perceptible, were very trifling—too minute for signalling. Previous experiments had failed to show the extremely rapid rate at which energy is absorbed with the depth or thickness of water. The energy is absorbed in forming eddy currents. Although this experiment has failed through water, it is thoroughly practical through air to considerable distances where it is possible to insert wires of similar length on each side of the distance to be crossed. It is not always possible, however, to do this, nor to get the requisite height to secure the best effect. It is impossible on a light ship and on rock lighthouses. There are many small islands—Sark, for example—where it cannot be done.

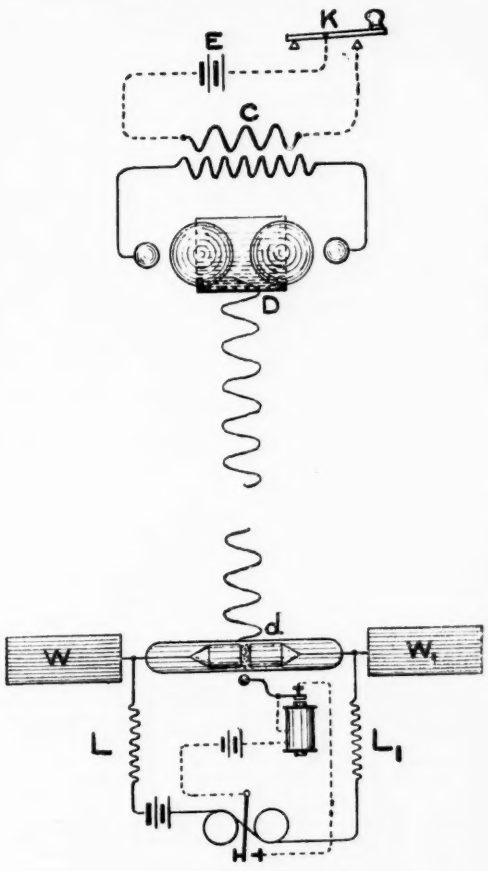


FIG. 2.

In July last, Mr. Marconi brought to England a new plan. My plan is based entirely on utilising electro-magnetic waves of very low frequency. It depends essentially on the rise and fall of *currents* in the primary wire. Mr. Marconi utilises electric or Hertzian waves of very high frequency, and they depend upon the rise and fall of electric force in a sphere or spheres. He has invented a new relay which, for sensitiveness and delicacy, exceeds all known electrical apparatus.

The peculiarity of Mr. Marconi's system is that, apart from the ordinary connecting wires of the apparatus, conductors of very moderate length only are needed, and even these can be dispensed with if reflectors are used.

The Transmitter.—His transmitter is Prof. Righi's form of Hertz's radiator (see fig. 2).

Two spheres of *solid* brass, 4 inches in diameter, are fixed in an oil tight case of insulating material, so that a hemisphere of each is exposed, the other hemisphere being immersed in a bath of vaseline oil. The use of oil has several advantages. It maintains the surfaces of the spheres electrically clean, avoiding the frequent polishing required by Hertz's exposed balls. It impresses on the waves excited by these spheres a uniform and constant form. It tends to reduce the wave lengths—Righi's waves are measured in centimetres, while Hertz's were measured in metres. For these reasons the distance at which effects are produced is increased. Mr. Marconi uses generally waves of about 120 centimetres long. Two small spheres are fixed close to the large spheres and con-

nected each to one end of the secondary circuit of the "induction coil," C, the primary circuit of which is excited by a battery, E, thrown in and out of circuit by the Morse key, K. Now, whenever the key, K, is depressed, sparks pass, and since the system contains capacity and electric inertia, oscillations are set up in it of extreme rapidity. The line of propagation is D *d*, and the frequency of oscillation is probably about 250 millions per second.

The distance at which effects are produced with such rapid oscillations depends chiefly on the energy in the discharge that passes. A 6-inch spark coil has sufficed through 1, 2, 3, up to 4 miles, but for greater distances we have used a more powerful coil—one emitting sparks 20 inches long. It may also be pointed out that this distance increases with the diameter of the large spheres, and it is nearly doubled by making the spheres solid instead of hollow.

The Receiver.—Marconi's relay (see fig. 2) consists of a small glass tube 4 centimetres long, into which two silver pole-pieces are tightly fitted, separated from each other by about half a millimetre—a thin space which is filled up by a mixture of fine nickel and silver filings,

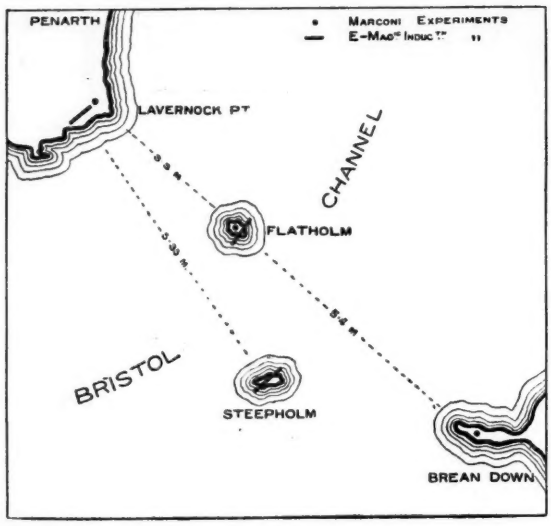


FIG. 3.

mixed with a trace of mercury. The tube is exhausted to a vacuum of 4 mm., and sealed. It forms part of a circuit containing a local cell and a sensitive telegraph relay. In its normal condition the metallic powder is virtually an insulator. The particles lie higgledy-piggledy, anyhow in disorder. They lightly touch each other in an irregular method, but when electric waves fall upon them they are "polarised," order is installed. They are marshalled in serried ranks, they are subject to pressure—in fact, as Prof. Oliver Lodge expresses it, they "cohere"—electrical contact ensues, and a current passes. I am able to illustrate this by another pretty contrivance of Prof. S. P. Thompson. The electric resistance of Marconi's relay—that is, the resistance of the thin disc of loose powder—is practically infinite when it is in its normal or disordered condition. It is then, in fact, an insulator. This resistance drops sometimes to 5 ohms, when the absorption of the electric waves by it is intense. It therefore becomes a conductor. It may be that we have in the measurement of the variable resistance of this instrument a means of determining the intensity of the energy falling upon it. This variation is being investigated both as regards the magnitude

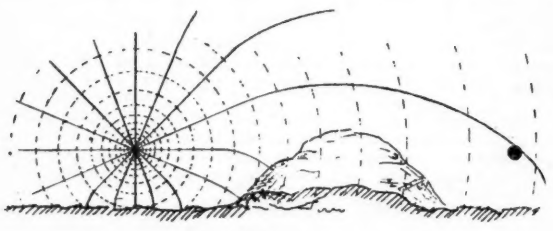


FIG. 4.

of the energy and the frequency of the incident waves. Now such electrical effects are well known. In 1866 Mr. S. A. Varley introduced a lightning protector constructed like the above tube, but made of boxwood, and containing powdered carbon. It was fixed as a shunt to the instrument to be protected. It acted well, but it was subject to this coherence, which rendered the cure more troublesome than the disease, and its use had to be abandoned. The same action is very common in granulated carbon microphones like Hunning's, and shaking has to be resorted to to decohere the carbon particles to their normal state. Mons. E. Branly (1890) showed that copper, aluminium and iron filings behaved in the same way. Prof. Oliver Lodge, who has done more than anyone else in England to illustrate and popularise the work of Hertz and his followers, has given the name "coherer" to this form of apparatus. He has much improved it. Marconi "decoheres" by making the local current very rapidly vibrate a small hammer head against the glass tube, which it does effectually, and in doing so make such a sound, that reading Morse characters is easy. The same current that decoheres can also record Morse signals on paper by ink. The exhausted tube has two wings (W and W_1), which, by their size, tune the receiver to the transmitter. Choking coils (L and L_1) prevent the energy escaping. The analogy to Prof. Silvanus Thompson's wave apparatus is evident. Oscillations set up in the transmitter fall upon the receiver tuned in sympathy with it, coherence follows, currents are excited, and signals made.

In open clear spaces, within sight of each other, nothing more is wanted; but when obstacles intervene, and great distances are in question, height is needed, tall masts, kites and balloons have been used. Excellent signals have been transmitted between Penarth and Brean Down, near Weston-super-Mare, across the Bristol Channel, a distance of nearly 9 miles (fig. 3). I must now show the system in operation.

Mirrors also assist and intensify the effects. They were used in the earlier experiments, but they have been laid aside for the present, for they are not only expensive to make, but they occupy much time in manufacture.

It is curious that hills and apparent obstructions fail to obstruct. The reason is probably the fact that the lines of force escape these hills. When the ether is entangled in matter of different degrees of inductivity the lines are curved, as in fact they are in light. Fig. 4 shows how a hill is virtually bridged over by these lines, and consequently some electric waves fall on the relay. Weather seems to have no influence; rain, fogs, snow and wind, avail nothing.

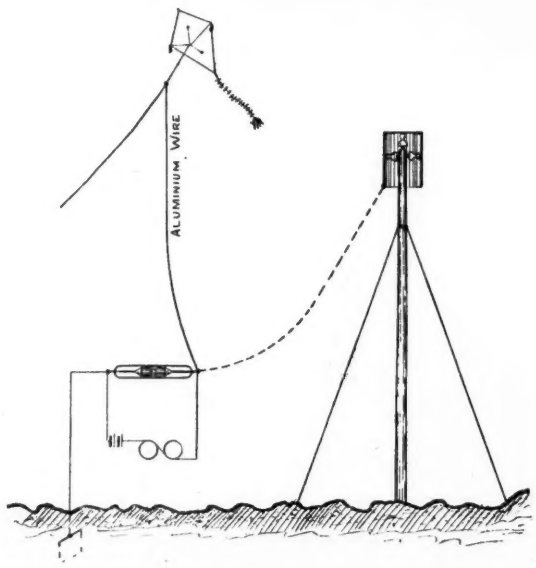


FIG. 5.

The wings shown in fig. 2 may be removed. One pole can be connected with earth, and the other extended up to the top of the mast, or fastened to a balloon by means of a wire. The wire and balloon covered with tin foil or kite becomes the wing. In this case one pole of the transmitter must also be connected with earth. This is shown by fig. 5.

There are some apparent anomalies that have developed themselves during the experiments. Mr. Marconi finds that his relay acts even when it is placed in a perfectly closed metallic box. This is the fact that has given rise to the rumour that he can blow up an ironclad ship. This might be true if he could plant his properly tuned receiver in the magazine of an enemy's ship. Many other funny things could be done if this were possible. I remember in my childhood that Capt. Warner blew up a ship at a great distance off Brighton. How this was done was never known, for his secret died shortly afterwards with him. It certainly was not by means of Marconi's relay.

The distance to which signals have been sent is remarkable. On Salisbury Plain Mr. Marconi covered a distance of four miles. In the Bristol Channel this has been extended to over eight miles, and we have by no means reached the limit. It is interesting to read the surmises of others. Half a mile was the wildest dream.*

"I mention 40 yards because that was one of the first out of door experiments, but I should think that something more like half a mile was nearer the limit of sensibility. However, this is a rash statement not at present verified."—Oliver Lodge, 1894, "The Work of Hertz," page 18.

It is easy to transmit many messages in any direction at the same time. It is only necessary to tune the transmitters and receivers to the same frequency or "note." I can show this here, but we are bothered by reflection from the walls. This does not happen in open space.

* "Unfortunately at present we cannot detect the electro-magnetic waves more than 100 feet from their source."—Trowbridge, 1897, "What is Electricity," page 256.

There are a great many practical points connected with this system that require to be thrashed out in a practical manner before it can be placed on the market, but enough has been done to prove its value and to show that for shipping and lighthouse purposes it will be a great and valuable acquisition.

THE "APOSTOLOFF AUTOMATIC TELEPHONE."

We publish in another column a report of the meeting of the "Parent Syndicate," which was called "to discuss the development and progress of the company," and to knock down to the bidders of the highest premiums a limited number of shares in a new company proposed to be formed. The auction sale was postponed. A committee of shareholders was appointed instead, and an adjourned meeting will be held to-day at noon.

The chairman's outline of the progress and development of the company is of a truly remarkable nature, and is briefly as follows:—There were eight signatories to the articles of association, two of whom provided the entire working capital, namely, the Honduras Government Banking and Trading Company and the chairman himself. A model of the invention had been completed, a demonstration given, and experts invited to examine the invention. £500,000 had been asked for the patent in one European country, the figures being arrived at upon the basis of 30 per cent. of the economy estimated to be effected by the use of the invention. The price seemed high, and in order to substantiate the claims the European "Monopoly" who were being negotiated with, "asked the inventor to solve a certain problem which presented itself in underground working." Mr. Apostoloff "found a technical solution of the problem," but the company "wanted something more practical," and "they found it necessary to call in a gentleman for the purpose." This gentleman—"a well-known engineer occupying a high position in the telephone department of a European Government"—was so satisfied of the value of the invention, that he was prepared to resign his position and forfeit his pension, in consideration of the payment of £5,000 in cash and £10,000 in fully paid shares for five years' services. The only other important item of "development and progress" reported was the incurring an indebtedness of £1,300.

Upon such a report the shareholders were asked to form a new company, pay the indebtedness of the old company, remunerate the directors and officers for their services, and compete with one another for the privilege of providing £10,000 "working capital," of which one-half should be handed over to an un-named European engineer, who had been good enough to express his confidence in the invention, and to offer his services on terms.

We know that considerable reliance is sometimes placed on the technical ignorance of the public; but we cannot call to mind any more extraordinary proposal made in apparent seriousness before assembled shareholders and press representatives. It does not surprise us to learn that the directors found it necessary to call in outside assistance when they wanted "something more practical," and one result of failing to raise the new working capital will certainly be the loss to the company of a most practical man. The combination of business capacity with engineering knowledge is not common. An engineer who would be entitled to a pension "in a few years" is probably not under 50 years of age. The investment of £5,000 in a Post Office annuity will realise £333 a year guaranteed by the British Government to any person between 50 and 51 years of age. This does not take into account the value of the shares, but we can probably waive those when considering the sacrifice this eminent gentleman is prepared to make. It is our impression that Continental pensions to technical officers do not rule high; but if, at the adjourned meeting, the chairman will say how much this engineer's pension would amount to, the shareholders will be able to compare it with the purchasable annuity, and judge of the value of the engineer's opinion of the invention. The independent shareholders would do well to leave the provision of new capital to the Honduras Government Banking and Trading Company, and Mr. Max Margowski. They understand that "the invention may be worth £2,000,000, or 2d." They do not comprehend the possibility of its being worth less than 2d.; but in case it should happen to be so, the ordinary investor does well to be out of it.

CORRESPONDENCE.

Rapid Cable Laying for War Purposes.

Let me preface my reply to your criticism on the above by thanking you for the straightforward course you have taken in *first* publishing the original lecture, that the exact account may be before your readers, and *then* subjecting it to criticism. It is a great pleasure to feel that the balance is held evenly, and that covert attack, by taking advantage of the absence of information on the part of your readers, is not indulged in.

I think an explanation is necessary, as to the peculiar character of the paper, in that it has a small body and a string of appendices as long as a kite's tail. The reason being that an outline, to show that a tangible mechanical scheme had been prepared, was first given, then the blockade problem was brought forward, with a map, so that the influence of a submarine cable upon the issue might be fully discussed, and *if* details of appliances should be asked for they could be given from the appendices. These were abridged as much as possible, and accounts for the want of full explanation in some parts.

At the outset let me say that I do not consider it worth while to closely discuss the advantage, or otherwise, of the use of a large drum, as it is too limited in range. It was given as showing that there are various ways of making up an equipment, and to prevent an adverse attack upon the small unit system (which I had not fully settled), causing a premature closing of the debate by making the high-speed laying of the cable appear almost a mechanical impossibility, and its value, therefore, not worth discussing.

Let me now deal with the accumulator, as the exact understanding of its capacity affects the criticism upon the rest of the paying-out gear. Referring to your issue of May 14th, the diagram, No. 3, explaining the genesis of the accumulator, may be considered as illustrating a typical appliance. Now the tangent sheave, on account of the weight, w, or its equivalent motor, always maintains a steady stress upon the cable; if, then, the accumulator is kept half charged, that is carrying only 1,000 feet of cable, it is plain that when the "ejector" astern makes a demand in excess of the rate the main drum is running, assuming for the time the large power driven drum carries the cable, it begins to eat up this reserve of 1,000 feet; in doing so, however, weight, w, is lifted, and the driver at the main drum will increase his speed to bring it down again. This weight, or its equivalent, is his guide in driving.

If the main drum be over-driven, the weight begins to fall below the normal level, and the reserve "grows" upon the accumulator, thus a mild form of "hunting" occurs, with what small risk of great amplitude arising is readily understood when it is considered that 10 per cent. increase in speed can be given to the main drum in 10 *secs.*, whilst it would take many *minutes* for a 10 per cent. discrepancy between supply and demand to affect the accumulator to the extent of its 1,000 feet. In this instance no drum of the accumulator would have power applied to rotate it, merely a motor to keep tension on through the tangent sheave, and the *normal* position is half full, any variations therefrom being met by increase or decrease of speed to the main drum.

This answers your objections, I think, in as concise a form as value of space permits. I note that you misquote in using the word "loosening" as regards the bight, it is "lessening," for in this application there is no variation in the tension on the bight throughout the whole range of 2,000 feet, though it may lessen or increase in length from its half-full position. Now let us analyse the capabilities of an accumulator in its relation to the small unit, in all ways the better, system.

If I can ease down, so as to practically stop, my receiving drum, which, in this application, we will consider *is* power driven, I can clear my overhead gear very readily. We will imagine that a 40 knot drum is becoming used up, which may be (as a simple method) readily signalled by the last 2,250 feet of cable on each drum being coloured a brilliant red, the rest being black. After the coloured part first becomes

visible on the receiving drum, both drums in this case being *normally* kept fairly full, it will take (at 30 feet per second) say, one minute before both drums get covered entirely with red cable, when this is accomplished the driver begins to apply his brake to the receiving drum and may take 15 seconds in which to bring it to rest, you will find 5 seconds ample if you figure out the result of, say, a 200 lb. brake effect on a 3 feet brake drum, the accumulator drums being 6 feet diam. To ensure stopping within 15 seconds, let us suppose the cable is marked red as above, but after the first 500 feet it has a length of 20 feet coloured black, this will then appear when the drums are otherwise quite full of red cable, like a black ring on the delivery drum, a foot from the end, towards which it will travel at the rate of a foot in 15 secs. By the time it has reached the end of this drum the receiving one has been quite stopped or preferably is merely crawling, I can then go on at this very slow rate for 15 seconds more, during which 500 feet more cable has been drawn off the accumulator, then I start gently increasing my receiving drum speed and give myself 15 seconds to get up full speed again, I shall thus find I have transferred my supply *at the merest crawling pace*, from one cable drum to another, whilst the drums have never had less on them collectively than 1,000 feet of cable.

If it be thought that such brake manœuvres are difficult, let me point out that in colliery winding, with a dead load of over 7 tons at starting, a maximum speed of 60 feet per second is reached in 18 seconds, and stopping effected with equal facility and great accuracy. What a difference! Yet this is done every few minutes, whilst we require our transfer only once in two hours.

I think this explanation of the capacity of the accumulator to *gently* negotiate the transfer of cable does away with your suggested risk of the paying out gear starting so suddenly as to leave loose wire on a cable drum, but in any case I should "stop" the cable to the overhead gear that is awaiting its turn to come into action, as well as similarly treat the first few turns of cable on every drum. I use the word "stop" in its nautical sense, such as when a sail is rolled up and being in stops cannot become loose from the forestay until the sheet is pulled, when it breaks "out of stops," which are small lashings of spun yarn, or other convenient cordage easily parted under a vigorous pull.

Although the use of the accumulator would give facilities for clearing the paying-out gear by hand, as the slowing down of the receiving drum is followed by a similar retardation of the paying-out gear, it is easy to effect the clearance automatically as the tail wire upon reaching the deck level may be led in a circular path along the edge of the hatchway in a reverse direction to the previous unwinding, thus causing a side pull upon the vertical wheel, or even a complete backward taking off, for this rotating gear is now stationary. The overhead wheel must naturally swivel, as the pull instead of tangentially vertical, can be made to draw sideways. However, although I submit this explanation, I have made modifications that will, I think, quite take away any risk of trouble, and, in due course, they will be made public, as well as the equipment and manipulation of an installation as applicable to a merchant cruiser.

If you will permit, I will continue in another issue the reply to your other points of criticism.

C. Scott Snell.

53, Victoria Street, S.W.

The Advantages of Insulated Iron Pipe for Electric Wiring.
(A Reply to Mr. V. Zingler.)

In his recent articles in the Electrical Review (appearing May 7th, 14th and 21st), Mr. V. Zingler has dealt with the question of "uninsulated" or plain iron pipe as against insulating lined pipes for electric wiring purposes, and whilst stating *pros* and *cons* for both sides, evidently wishes his readers to favour plain iron pipe.

What few technical criticisms he has advanced against insulated pipes or conduits can be easily answered, and had perhaps better be dealt with than left unnoticed.

Whilst Mr. Zingler has for the composition of his article made full use of the various letters published in the N.Y. *Electrical World* (February 15th and 27th, March 6th and 13th)—which were replies received from prominent engineers and contractors in the United States in answer to the circular letter on the subject sent out by the above-named journal—he is somewhat unfortunate in his choice of expressions to indicate that the particular writers quoted, favour the side he has taken. He quotes Mr. W. A. Anthony's letter of February 15th * as "hitting the right nail on the head" for advocating "high grade wires, less braid and a "smooth lining to the pipe," and suggests that if Mr. Anthony has not "made a slip" by suggesting an *insulating lining* as the best means of obtaining a *smooth interior*, he (Mr. Zingler) will be obliged to disagree with him. This is perhaps, to be regretted, but in order to have obtained Mr. Anthony's real views, Mr. Zingler should have finished reading the letter and quoted the last sentence. "If plain iron pipe is to be used at all for conduits, it must in some way be rendered absolutely smooth and free from fins and splinters inside . . . no one would claim that such an installation (that is, plain pipe), would possess the same advantages as an installation consisting of *the same wire*, drawn into a *pipe having an insulating lining*, &c. . . . ." In another letter, dated March 6th, Mr. Anthony makes his views clearer by saying:—"I consider plain, or merely coated iron or steel pipe, inferior under any conditions, whatever may be the insulation of the conductor;" and, further, supports the argument we advance that the lining forms an additional safeguard, by saying that "even admitting the lining has defects," the chance of trouble is exceedingly small, because of the improbability of defects both in the lining and the insulation of the wire coinciding.

Then, again, arguing from Mr. Ward Leonard's letter, Mr. Zingler dilates upon the statement, "exceedingly high insulation is of less importance than insulation, which will remain unaltered in the course of years," and although he has ascribed to our insulating lining "low insulation," forgets that the above statement favours us, unless he can prove that the "lining actually deteriorates the wire"—a task we feel we are safe in leaving him to undertake. Mr. Leonard's summation as to what would be perfection is given in the same letter (*Electrical World*, February 27th):—"The perfect conduit would be a strong metal pipe lined with a smooth, incombustible, highly insulating, but thin, wall of material, which could not be affected by chemicals," views which accord with, and are the goal for, the desires of "insulating pipe" advocates.

For the purpose of argument, possibly, it may be very desirable for Mr. Zingler to take an "absolute standard" of material and workmanship; but the writer, at least, has as yet been unable in practice to find it, very much less maintain it. It is true that plain iron pipe has proved satisfactory in the case of gas, water, and steam, because it provides the necessary mechanical protection from outside influences; but for our side of the question, we maintain that its application to electrical uses involves conditions that have not before been necessary to consider. In short, internal conditions before disregarded have then to be provided against, and the most highly insulated wires preferably require more than the "mechanical protection" and "accessibility" that Mr. Zingler claims iron pipe provides so sufficiently.

In the first place we contend that the insulating lining is valuable, as neutralising the effect of mechanical injury to the covering of the wire before or whilst it is being drawn into the pipe or conduit. The insulating lining of the conduit being completely under an iron armour, is not liable to damage.

A bitumenised lining is inert and permanent (we challenge Mr. Zingler to prove the contrary), and by lessening the deleterious internal influences, *must* preserve the insulation on the wire; in other words, the lining *is* a first cost investment against depreciation. The value of a lining to resist condensation and internal oxidation hardly needs demonstration; but the value of a substantial bitumenised lining in comparison with one of enamel or a thin coat of varnish (either of which must crack and peel when the pipe is handled or bent), can be readily tested by a few simple experiments. The "fin" and "burr" difficulty in wrought-iron pipes also necessitates a certain thickness of lining, and although we do not state that it is impossible to do good wiring work with plain pipe, we urge that lined pipe must be more certain, as we find and believe it is too onerous and confiding to expect the everyday workman to thoroughly ream and clear the end of every pipe he cuts. If plain iron pipe became

* See Electrical Review, April 9th.

the adopted standard for wiring, we should at once have every mechanic who handles pipe in any trade, the steam, gas and water-pipe fitter, and more than ever, the plumber, entering the electrical business with the belief that he could undertake all kinds of wiring. We think nothing would compel the change to insulating lined pipes quicker than the possibility of such a competition.

We are quite prepared to admit that "price" consideration must at first sight have some influence with small contractors and the public, but in making the comparison between the cost per 100 feet of plain pipe and the same sized insulating lined pipe, Mr. Zingler when drawing up a table should have inquired for present prices, and might also have made his comparison more intelligible. He appears to have taken our prices from an old list with a discount of $33\frac{1}{3}$ per cent. off, whereas with the increased demand for conduit the discount has been enlarged to 50 per cent., and a further 10 per cent. for quantities such as would command the discount of 75 per cent. off gas pipe prices which he works upon. His table requires amendment as below.

Iron-Armoured Insulating Conduit.

Inside Diameter.	As given by Mr. Zingler.	Present price.
$\frac{7}{16}$ths inch.	£2 10 0	£1 10 0
$\frac{5}{8}$ths inch.	£3 15 0	£2 5 0
$1\frac{5}{16}$ths inch.	£4 13 9	£2 16 0
$1\frac{1}{4}$th inch.	£5 12 6	£4 2 0

Upon an installation which costs complete, several hundred pounds, the proportionate cost of the casing, iron pipe or lined conduit is relatively quite small, and if largely increased only affects the total by a small percentage. Also when comparing these prices with plain pipe prices it will be well to remember that Mr. Zingler (without suggesting the means to be adopted) is willing to allow an increased price of 50 per cent. over that of ordinary iron pipe to obtain a tube with a *smooth interior*, and a further 10 per cent. for galvanising, and then $2\frac{1}{2}$ per cent. for coating the interior with a varnishing compound. With the suggestion that the above points should be attended to, it is evident that the views of both sides are not really so very far apart on some of the technical conditions.

Passing to the information given in respect to the installation of ordinary iron pipe, without wishing to criticise his practice, it is sufficient to say that contractors who have had experience with insulated pipe will not feel that the limitations set will apply to them in their conduit construction, and that as to bending and the number of bends and elbows that can be installed on a run of piping without using boxes, as well as the precautions it is necessary to take in respect to moisture, &c., they are at a distinct advantage in labour saving if using lined conduit. They know further, that owing to the lessened friction and internal smoothness of insulated pipe, they can often use one of smaller internal diameter than would be advisable with plain pipe, and so reduce prime cost.

In the main, Mr. Zingler's objection appears to resolve itself into the question of price, and our ability, therefore, to convince him that it is economy to use lined conduit, depends less upon argument than whether he will always be satisfied with the results he obtains from plain pipe. Time will best tell.

The writer would take this opportunity of removing the impression that insulating conduit advocates are still suggesting any reduction, in connection with the present 100-volt and 200-volt double wire systems, of the insulation on wires of the 300 megohm quality pure and vulcanised I.R. coverings. Whilst hopeful of improvement in other methods of insulating, they ask that present effort should be directed to reducing the outside diameters of insulated wires, so that twin conductors for 5-ampere capacity can be readily inserted in conduits $\frac{3}{8}$ths inch inside diameter, and for 10 amperes in those of $\frac{5}{8}$ths inch diameter. The recent formation of a limited company, which will undertake in England the manufacture of insulating lined steel piping will, it is hoped, solve practically and effectively this much debated question as to the merit of lined over unlined pipe.

Fred. Bathurst.

Ormond House,
63, Queen Victoria Street, E.C.

LEGAL.

Benn *v.* Electric General Investment Co.

In the Queen's Bench Division last week, Mr. Justice Bruce and a jury concluded the hearing of this, to which we referred briefly in a "Note" last week. It was an action brought by Mr. Chas. E. Benn, a financial agent, to recover £10,000 damages for alleged breach of contract. The defendants, by their pleadings, denied that any contract was made, and alternatively, if there was a contract it was made without their authority. They further alleged that plaintiff had suffered no damages. Mr. Sturgess appeared for plaintiff, and Mr. Jelf, Q.C and Mr. Tindal Atkinson for the defendant company. Mr. Sturgess, in opening the case, said his client carried on business in America as a financial agent and also in this country. In May of last year he obtained a ninety days' option from the Portland General Electric Lighting Company—an American company—a considerable number of mortgage bonds of 1,000 dollars each. That option should have come to an end in the ordinary course at the end of August, but it was eventually extended until the middle of November. The American company promised the plaintiff that in the event of his selling the mortgage bonds at their par or face value in England they would pay him a commission of five per cent. Plaintiff having obtained his commission note on the option, came to this country for the purpose of negotiating with some one or other to sell the bonds at their face value, he put himself into communication with the County of London and Brush Provincial Electric Lighting Company, Limited. Mr. Benn took all the papers he had with reference to the matter to the Company, and gave them full information as to the undertaking. Mr. Renwick, an officer of the County of London Company, looked through the papers, and then took the plaintiff to the manager of the company, a Mr. Lawson. Mr. Lawson said he knew all about the undertaking having been in America and having supplied them with materials. He also said that he could find someone who could do the business for the plaintiff, and who would purchase the bonds at their face value. Eventually the County of London and Brush Provincial Company communicated with the defendant company on the matter, and he (Mr. Sturgess) would prove that on August 7th the defendant company made an arrangement with the plaintiff to buy the bonds at the price named, and that by correspondence they made a definite contract with him to that effect. His point was that the County of London Company made an agreement with the plaintiff on behalf of the defendant company, and that the defendant company had repudiated it. He then proceeded to read the correspondence almost the whole of which his lordship ruled out of order, and as being no evidence against the defendants.

Ultimately, under the direction of his lordship, the jury returned a verdict for the defendants, and judgment was accordingly entered for them with costs.

Clement *v.* M'Donald.

At the Glasgow Court of Sessions on 2nd inst., Lord Kyllachy gave judgment in an action by Hugh Sprott Clement, manager British Patents Company, 121, West Regent Street, Glasgow, against Robert M'Lauchlan M'Donald, electrician, Strathtay, Perthshire. The pursuer sought a statement of accounts connected with an invention relating to primary electric batteries, and of the defender's whole intromissions with the assets derived from the working, sale, or hire of the invention, so that the balance due to the pursuer might be ascertained. Alternatively the pursuer concludes for £1,000. The pursuer founded upon a letter, dated February 19th, 1896, under which the defender assigned to him one twenty-fourth share in the patent, "for services rendered and other valuable consideration." The defender said that the letter was granted upon the representation that the pursuer had obtained a purchaser for the patent, and on the condition that the agreement should only become operative upon the completion of the purchase. Next day the pursuer stated that the purchaser would not complete the bargain, and it was maintained that the agreement thereby came to an end. Lord Kyllachy said the case seemed to him to be simply the sale of a reservation of a certain share in a certain visible subject. It was just as if the owner of a ship had, for a consideration assigned $\frac{1}{64}$th share of the ship, and retained the remaining shares, and that was a familiar transaction. Therefore, the pursuer's case proceeded upon what he considered to be an entire misapprehension of the agreement. He would therefore sustain the defender's plea against the relevancy of the action, and give the defender absolvitor, with expenses.

BUSINESS NOTICES, &c.

Another Interior Conduit.—Messrs. Veritys, Limited, are putting on the English market an interior conduit, which is known in the States as the Cummings system. It consists of a steel tube lined with wood, the special feature about it being that the wood, before being put into the tube, is soaked in an insulating compound of an oily nature. The wood is put into the pipe in two sections, one of which is tongued and the other grooved. Being soaked in the compound just before being placed in the tube, it swells, and becomes finally pressed against the interior of the pipe. The conduit is claimed to be absolutely fireproof, impervious to damp, and inexpensive.

Jubilee Illuminations.—Search lights will be used extensively both in London and the provinces for the purpose of illuminations this Jubilee time. Several 26-inch ones are being offered for sale by Messrs. Paterson & Cooper.

Electrical Wares Exported.

Week Ending June 8th, 1896.	£	s.
Alexandria. Teleph. mat.	38	0
Amsterdam	50	0
Auckland	45	0
Bombay	39	0
Brisbane	6	0
Buenos Ayres	209	0
„ Teleg. mat. ...	26	0
Calcutta	270	0
Cape Town	160	0
Colombo. Telephone ...	110	0
Durban	17	0
La Plata	299	0
„ Teleg. mat. ...	601	0
Port Elizabeth	138	0
St. Petersburg	136	0
„ Teleg. mat.	81	0
Shanghai	43	0
Singapore	17	0
Stockholm	18	0
Teleg. mat. ...	37	0
„		
Sydney	265	0
Trieste. Teleg. mat. ...	1,113	0
Wellington. Teleg. mat.	77	0
Total	£3,795	0

Week Ending June 8th, 1897.	£	s.
Adelaide	11	0
Amsterdam	75	0
Antwerp. Electric fuses	43	0
Baltimore. Teleph. mat.	22	0
Buenos Ayres	83	0
Calcutta	690	0
Colombo	20	0
Durban	341	0
Kobe	381	0
Madras	26	0
Melbourne	44	0
Perth	116	0
Rotterdam	31	0
St. Petersburg	28	0
St. Pierre, N.F. Telegraph cable	19,050	0
Shanghai	143	0
Sydney	55	0
Yokohama	381	0
Total	£21,540	0

Boiler Explosions.—The British Boiler Fluid and Engineers' Stores Company have issued a list, drawing attention to the Board of Trade report on the working of the Boiler Explosions Act during the year ended June 30th, 1896, for which period the returns show that 25 persons were killed and 48 injured by explosions which came under the notice of the department. Neglect on the part of steam users was the leading cause of the explosions. The company draw attention to their "Dejecoline" boiler fluid, which is claimed to prevent incrustation and economise the fuel bill. The fluid is, we understand, used at the Blackpool Corporation electricity works and the City and South London Electric Railway.

Electrical Concessions in Spain.—It appears from a report to the Foreign Office from Mr. Vice-Consul Toro, on the trade of Ponce (Spain) for 1896, that a company has been formed to establish electric light in the city and port of Ponce; the necessary capital ($60,000) has been subscribed locally, and the plant ordered from New York. A private party has obtained from Government a concession to run electric cars between the port and city of Ponce, covering also a few of the principal streets, in all about 4 miles; no contracts for building the road have as yet been made.

Liquidation Notices.—A general meeting of the Alternate Current Electro-Motor Syndicate, Limited, will be held at Penywern House, 2 and 4, Penywern Road, Earl's Court, S.W., on Friday, July 9th, at 5 o'clock p.m., for the purpose of hearing an account of the winding-up proceedings from the liquidators, Messrs. G. W. de Tunzelmann & C. E. Cree.

ELECTRIC LIGHTING NOTES.

Acton.—Mr. F. J. Warden-Stevens's letter, offering to advise the Council on the subject of the establishment of electric lighting and refuse destructor works has been filed for future reference.

Brechin.—Last week a special meeting of the Police Commission was held to meet Messrs. Gripper & Macleod, representatives of Edmundsons, Limited, with reference to the introduction of the electric light into the burgh.

Brighton.—The manager of the Bedford Hotel Company has written to the Lighting Committee stating that the directors had resolved to substitute electric lamps for all the gas burners in use. The following remarks added by him are worth reading:—"We once had a small plant, gas engine, accumulators, &c., and managed to run from 60 to 80 lamps. From the small experience I then gained, and from observations taken from several other much larger hotels, I am convinced that the cost is far in excess of the charges made by the Brighton Corporation, and, added to that, I am able to state that the absolute reliability and steadiness of the light is such that, during the six years we have had the Corporation supply, we have never been put to the slightest inconvenience, a thing that could not be said of any hotel that undertakes to supply with their own electric machinery."

Burnley.—The Council has increased the salary of Mr. W. R. Wright, electrical engineer, from £200 to £250 per annum. The profit on the last year's working of the electricity department was over £700.

Bury.—The Town Council has, upon the Electric Lighting Committee's recommendation, adopted the Brighton system of charging for electric current.

Cardiff.—Meter rent charges are to be reduced from 20s. to 10s. A cable is to be laid through the Central Arcade for the purpose of lighting shops as required, and for supplying current to work motors for driving the ventilating fans in the Arcade for Mr. Seward. The *Western Mail, Limited*, have applied to the Electrical Committee to have the premises of the Cardiff Conservative Club connected with the Corporation mains. The Committee has discussed the matter and referred it to Mr. Applebee, the electrical engineer, and the Town Clerk. The point raised was, that the *Western Mail* have a private plant, and are only connected to the Corporation mains so as to be prepared for emergencies. The club is at present being supplied with current from the *Western Mail* installation, and wishes to be connected to the Corporation mains for the same reason. It was suggested by a member that the *Western Mail* should, under such circumstances, be charged the maximum rate, 8d. per unit.

Eccles.—The Board of Trade has agreed to defer the question of the revocation of the provisional electric lighting order for a period of 12 months, in response to the Council's request.

Galway.—The Bill confirming, among other provisional orders, that of the Galway Electric Company, Limited, was last week ordered to be reported for second reading.

Halifax.—The Gas Works Committee recommend that the salary of Mr. T. P. Wilmshurst, the Borough electrical engineer, be increased from £250 to £300 per annum.

Islington.—In reply to a question as to what number of the private householders and shopkeepers had availed themselves of the electric light installation, Mr. Lambert stated last week that in the compulsory area—from the "Angel" to Finsbury Park—there were 870 business premises, and out of that number 161 had been connected with the mains. There are in the same area 120 private houses, and of that number 9 have been connected with the Vestry's mains, or 17 per cent. The Vestry has resolved to revise the scale of charges for private supply on October 1st next. The charges will range from 7d. to 4d. per unit, according to the current consumed.

Leith.—Prof. Kennedy reports that as to the system of electric supply to be adopted, there are no special difficulties or complications occurring in Leith, and he advises a three-wire system, with lamps supplied at 230 volts. He recommends the Council to provide plant and mains for supplying from 10,000 to 12,000 8-C.P. lamps, wired, besides providing for the arc lamps (64 in number) necessary to light the scheduled area. For this purpose there will have to be placed in the station plant of about 400 H.P., besides a spare set of, say, 250 horse-power. The total cost will be from £33,000 to £35,000. He recommends a charge of 6d. per unit, or, perhaps, as low as 5d.

Liverpool.—The City Council has agreed to the recommendation of the Finance and Estate Committee, to which we referred last week, to borrow a sum not exceeding £100,000 for extensions and additions to the Corporation electric light undertaking which have been already, or may be hereafter, authorised by the Council.

Manchester.—A Local Government Board inquiry was held here on 3rd inst. into the City Council's application for sanction to borrow £130,000 for electric lighting extensions. The success of the installation was referred to at considerable length.

Newington.—The Vestry Clerk of Newington (Mr. L. J. Dunham) has forwarded a letter to the Board of Trade in connection with the electric lighting order, in which he states:—"The electric lighting question was very prominently brought before the electors on this occasion (the Vestry election), with the result that out of 25 vacancies, the Progressists returned 14, as against 11 Moderates. Of the 25 vacancies two were Moderates, so that the Moderate gain is nine seats. If the electric lighting had been the sole question before the electors, it is the general opinion that the Progressists would have secured a larger number of seats; but personal matters were introduced into the election, which secured in the wards of St. Paul's and Trinity the return of the whole of the Moderate candidates. It is worthy of note that although every effort was made to throw out Mr. Cole (chairman of the Electric Lighting Committee) not as Mr. Cole, but as chairman of the committee, this member was returned at the top of the poll." The Board of Trade had asked to be informed of certain particulars in regard to this election, and that is the reason why Mr. Dunham sent the above letter.

Nuneaton.—The Electric Light Company switched on the current at their lighting station last Saturday evening, the ceremony being performed by the chairman, Mr. R. Stanley. As an advertisement, the company will supply electric current free of charge on Jubilee day to anyone in Nuneaton who provides the requisite fittings.

Sale.—The District Council has decided to engage Mr. Shaw, of Ashton-on-Mersey, to prepare a scheme with specifications, estimates, &c., for the electric lighting of the entire district, at a fee of 30 guineas. Before finally adopting a scheme, the opinion of another electrical expert is to be obtained.

Salford.—The Town Hall (including the assembly room and two ante-rooms), is to be provided with an electric lighting installation, the work to cost £724.

Shanklin.—The question of electric lighting was discussed at the last Council meeting. It was proposed that the clerk communicate with firms who undertook electric lighting, to ascertain the cost of lighting the district. The motion was, however, lost by a majority of one vote (four to three).

Sheffield.—The question of purchasing the electric light works was before the City Council last week, and was finally decided, a resolution being passed as follows:—"That the Parliamentary Committee be empowered, should they deem it desirable, to affix the Corporate common seal to an offer to be made to the Sheffield Electric Light and Power Company, Limited, of a sum of £200 of new Sheffield

Corporation 2½ per cent. stock (or in the alternative £200 in cash) for every sum of £100 properly expended by the company, chargeable to capital account, together with a sum in cash equal to the aggregate amount of a dividend of 5 per cent. per annum of the dividends declared by the company from the date or dates of such expenditure; such offer of stock and cash being the price for the purchase of the company's undertaking, pursuant to the notice to purchase dated April 15th, 1897, given under the powers of Section 60 of the Sheffield Order of the Electric Light Confirmation (No. 4) Act, 1892, and that in default of an agreement to purchase the undertaking of the company being come to by the Committee, the Town Clerk be instructed to take such measures as he may be advised, to enforce the requirements contained in such notice."

Shoreditch.—Arrangements for the opening of the electric light works at the end of this month are in the hands of a sub-committee. Lord Kelvin has consented to perform the opening ceremony.

Southport.—The annual report on these works states that the output has increased from 89,979 units sold during the year ending December 31st, 1895, to 245,515 for the year ending March 31st, 1897; and the revenue from £2,039 to £4,837. The total expenditure has at the same time increased from £2,254 to £5,309, so that there is a net deficit for the year of £471. This result is, according to a local paper, due entirely to the great increase in the sinking fund and interest, which figures at £2,459, as against £861 for the previous year. During the present year the increase in this item will be small.

Stockport.—The Council has resolved to put down an electric light installation at a cost of about £25,000, which sum is to be borrowed. Mr. Webb, the Chairman of the Electric Lighting Committee, stated at the last meeting that it was hoped to have the light in use by September, 1898. The continuous current system would be adopted, as it could be easily applied to tramways, motors, &c.

Tunbridge Wells.—There was a long discussion on electric lighting matters at last week's meeting of the Town Council. The recommendation of the committee for the increase of Mr. Boot's salary from £250 to £350 evoked a short commentary on the increase of the salary of a comparative new official by £100, whilst old officials were overlooked, but the increase was granted, the critics contenting themselves with giving notice of proposals to give other officials a similar increase. A letter from Sir David Salomons was read, in which he drew attention to the point that in the ordinary course so large a profit as is now shown on the electric lighting works is not likely to occur again, for though the actual sum might be as large, the profit would not be so in relation to the capital employed. The letter proceeded: "The installation has been strained to the utmost and with no reserve. By good fortune and management breakdowns have been avoided, but common sense shows this state of things cannot last, and the fact of fresh capital being spent is a proof that such must be the case. We have at present a fund in the shape of paying off the capital, but this is far too small for practical requirements. Experience has shown that although the wear and tear may be small in early years, many unexpected outlays crop up at later stages. I would not advocate the piling up of a fund simply upon a theory, but I strongly urge that when the surplus permits, a sum equal to 5 per cent. on the capital outlay upon the machinery, mains, &c., be set aside. Indeed, 5 per cent. upon mains and transformers is scarcely sufficient, so that 5 per cent. all round on capital expenditure is about right. This 'depreciation fund' would not go on accumulating, for all renewals in successive years would come out of this fund, and the profits will be relieved when the end of the financial year is reached to that extent, and if no profit is made in any year, or insufficient to meet renewals, then the ratepayers will not be called upon to make good such expenses, It would be a fatal mistake to regard the ratepayers' pockets as the fund for depreciation and renewals, for though to-day the rates may be relieved, years may come when this will not be the case, and if commercial prudence is now exercised, I firmly believe that in any bad year the ratepayers will not be asked for a penny. The repayment of capital, so far as the ratepayers are concerned, is a fallacious matter; for say at the end of twenty years by theory the installation will be three-fourths worn out. Yet no part of the capital can be touched to set things in order, and a new loan might not be granted for such a purpose, though fair on principle consequently in practice unless a depreciation or reserve fund is started when good years come round the ratepayers may at any time be called upon to make good all large renewals. To put such a fund into existence will cost nothing and be productive of good. I urge most strongly that half the present surplus be placed to such a fund, and thus make a good start. The money would be invested and not lie idle. The principle I advocate is adopted by the City of London Electric Lighting Company, but on a larger scale, settled by special Act of Parliament after careful inquiries that capital does not touch the case, as some would believe, since capital paid off cannot be reclaimed, and finally at the end of the time the ratepayers will possess an installation kept up to date, with borrowing powers equal to the original capital expenditure at their disposal. The course proposed is also equitable in principle; the advantages are distributed equally over the present generation instead of profits being given to ratepayers who exist in any given era." The town clerk said the Council in their Improvement Act had a clause which enabled them to establish a renewal fund for water works purposes, and that had worked exceedingly well on the lines suggested by Sir David Salomons. Unfortunately, however, Parliament had not given them the same powers as regards electric light works, and their profit balance could only be devoted to a reserve fund to be invested and accumulated to one-tenth of the capital, when the difficulty would arise as to what they could use the reserve for; viz., any deficit or any extraordinary demand or claim, the surplus to be for the benefit of the local rates. It would be foolish to set aside a reserve fund which they could not touch except for these two purposes. They were insured against accidents, and therefore an extraordinary claim would not arise under that head. Any business person would have thought Parliament would have provided for what Sir David recommended, but such was not the case.

Westgate-on-Sea.—The Parochial Committee have resolved to supply Eastlakes, Limited, of 14, Parliament Street, Westminster, with particulars as to area, population, &c., with a view to that firm formulating a scheme for the electric lighting of the district, where the present charge for gas is 4s. 9d. per 1,000 cubic feet.

Worthing.—The Town Council have received a letter from Mr. R. Rowe, stating that he is prepared to form a company for the purpose of introducing the electric light into the borough, and inquiring whether the Council would be prepared to transfer to himself or his nominees the provisional order obtained from the Board of Trade. It was resolved last week to ascertain if Prof. Kennedy would act for the Council in the matter should the Council be desirous of proceeding with their order.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Belfast.—A lengthy discussion took place at the Corporation meeting last week on the question of the lease to be granted to the tramway company for the tram lines of the city. A resolution previously passed deciding not to extend the lease was rescinded.

Blackburn.—It is understood that the Corporation is recommended to accept the tender of Messrs. Siemens Bros. & Co. for the whole of the Corporation part of the electric tramway works. The plans of the route and regulations as to the cars, &c., on the proposed new electric tramway on the Preston Road and Witton sections at Blackburn have been approved by the committee. The company are to be allowed the use of cars accommodating 50 passengers—24 inside and 26 outside—but advertising on the upper portion of the cars is forbidden. The town terminus of the Preston Road section will be in front of the station, and that of the Witton section in front of the Crown Hotel. The cars are not to be stopped at all on the outward journey on the following short lengths of the Preston Road route: between Duke's Brow and Adelaide Terrace, and between Adelaide Terrace and Leamington Street.

Blackpool.—At last week's Town Council meeting Councillor Brodie, in moving the adoption of the Electric and Tramway Committee's minutes, said the year's working of the electric lighting department had resulted in a profit of £800. That was very gratifying, in view of the many difficulties to contend with. In the tramways estimates it was expected that the profits would be £2,400. The receipts were £13,300, but the profit was only £300. Some three or four months ago the committee went into the whole matter, and found some very extravagant expenditure going on. Alterations were accordingly made. It was estimated that £250 would be sufficient to keep the channel clear, but it had cost £1,295. The minutes were adopted.

Brighton and Rottingdean Railway.—In reference to our note last week, we are informed that the reconstruction of the mechanical and electrical portion of this railway was carried out by Messrs. Stephens, Smith & Co., at Millwall, to the order of Mr. Magnus Volk, as consulting electrical engineer, and Mr. St. George Moore, of 17, Victoria Street, Westminster, as consulting mechanical engineer.

Central London Railway.—This company has officially notified its withdrawal of the Bill deposited by it for the present session for power to acquire certain lands on the north side of Oxford Street, and to alter the position of its station under Oxford Street, near Marylebone Lane. The Bill was to have been opposed on second reading in the House of Commons.

Dublin.—The Dollymount and Sutton electric tramway scheme, which is an extension of the Dublin United tramway line from its termination at the former place to the Sutton Cross Roads, about four miles distant, has passed the County Dublin Grand Jury. It is interesting to learn that of 650 cards sent out to elicit opinions of residents and property owners in the district regarding the scheme, 600 were returned approving and 15 disapproving. This line will join at Sutton Cross Roads the electric tramway round Howth to be put down by the Great Northern Railway Company, who have now got their Bill passed.

Electric Motors in Printing.—The printing machines of the *Belfast Evening Telegraph* are now worked by means of electric motors. Mr. Walter Chambers, C.E., superintended the work. There are three Lundell motors, each developing 20 to 25 H.P. Current is taken from the Corporation supply at 220 volts. Messrs. J. H. Holmes & Co. supplied the motors, and the installation was fitted up by Messrs. Wm. Coates & Sons, of Belfast.

Electric Tramcar Accident.—Last Saturday afternoon, a collision occurred between two electric tramcars at Haddington Road, Dublin, the result of which was that William Kavanagh, a conductor, received a fracture of the right thigh and leg, which resulted in his death. Thomas Connolly, a brakesman, was arrested on a charge of having been absent from one of the cars, so that it ran into an incline and caused the collision.

Fraudulent Accident Claims.—It is, perhaps, hardly necessary to claim greater professional standing for English lawyers than for their American brethren: doubtless there are many of the "shyster" or "shark" element amongst the attorneys of this country, but across the Atlantic it seems to be fair business for men of decent professional standing to take up what are in reality "fake" or bogus accident claims on the principle, we suppose, that railway and tramway companies are fair game for shooting at. The other week, for instance, a slight collision between two electric cars happened in Baltimore; no one was really hurt, but claim was at once made by a passenger for damages in respect of a broken arm. At least £400 would be required to make it better, according to the lawyers engaged! The tramway company asked the injured passenger (who had his arm in splints, and a doctor's certificate) to allow an X ray print to be made of the arm. After some demur he consented: the first one was spoiled by movement of the arm (rather a suspicious thing in itself); the second showed an arm perfectly sound throughout, and, as a consequence, the company refused to pay. The limbs of the law offered to compromise for £5 (a considerable drop from the first claim), but nothing was paid, and the fraudulent claimer left the city at short notice, doubtless fearing that he would be proceeded against. Another triumph for science—"Villany vanquished and virtue victorious."

Glasgow.—A London firm has been bringing the Shain oil motor before the notice of the Corporation, with a view to obtaining a trial of same on the tramways.

A large sub-committee has been appointed to lay down the new Springburn electric tramway, the instructions given to the committee being to do it in the best manner that can be devised, and to have the work completed as expeditiously as possible. To this sub-committee has been remitted the question of considering whether the electric power for the tramways should be taken from the John Street Station, or whether, as some propose, a new power station should be erected at Springburn.

Liverpool.—The Tramway Committee discussed the proposed substitution of mechanical for horse traction last week, and Mr. Pearson, an American expert in electric traction, was heard at considerable length. No decision was arrived at.

Mexico.—An American contemporary says that the electric railway between Cordova, Mexico and Jalapa, is approaching completion, 2,000 men now being employed upon the work. This, it is stated, will be the first electric railway in Mexico, and from the fact that it is 75 miles in length, Mexico will have something to be proud of.

Third Rail Equipment on the New York, Newhaven, and Hartford Railway.—While not unduly crowing over the recent equipment of a dozen miles or so of main line for electric traction, the American electrical papers seem (at least to a foreign mind) to wander a little and get inconsequent as regards some of the details and methods adopted. The *Electrical World*, for instance, speaks of the line pressure (600 volts) as being necessarily kept low on a third rail system like this, liable to accidental contact from workmen and trespassers, and also states that the difficulty of making "flying switches" is apparent. With regard to the first point, probably workmen would just as soon get a 600-volt shock as one of 1,000 volts; the one kicks almost as much as the other. The limits of continuous current working are fixed rather by ease of commutating at the motors than by possibilities of danger from shock. That is, third rail working up to say, 1,200 or even 2,000 volts continuous, will, in all probability, come into use, given success in insulation of the conductor rail under ordinary conditions. Trespassers will have to look out for themselves; of course there are many more of the tribe in the United States than here. "Tie-counters" in this country soon get ordered off, if seen by platelayers or other employés of the line. As to the second point, perhaps we do not grasp the meaning that our contemporary wishes to give to the term "flying switch." In the sense that we have always been accustomed to take it, we see no greater difficulty in the operation with electric trains than those worked by a steam locomotive. If anything, it ought to be easier; but "fly shunting" isn't a thing to be encouraged anyway. By the way, either this line or the Nantasket Beach section of the same system (already equipped with third rail and trolley on different portions) is the one of which Mr. Clark, the president, is reported to have said that all the rails (including the conductor) "were under water for hours, but the cars went on just the same." Mr. Clark is a far-seeing and energetic railroad president; but as a practical expert in electricity, he seems to be a little out. Perhaps a justifiable degree of pride in taking foremost rank is sufficient cause for a piece of exaggeration that any tyro would detect.

Torquay-Paignton.—The Torquay Council last week had a short discussion regarding this electric tramway scheme, and from the remarks made it seems there will be a good deal of opposition. By 12 votes to 8 the draft order was referred to a meeting of the Council in Committee.

Yarmouth.—The Borough Surveyor has submitted his report on the question of electric tramways. The sum and substance of the report is a recommendation to adopt the overhead system. This, he says, appears to be the only system which can be carried out at a reasonable cost, the only drawback being the posts which occupy valuable space on narrow footpaths, particularly at corners. He recommends four different lines, the cost of construction, also rolling stock and buildings, totalling out at about £35,500, but this estimate did not include the cost of electrical plant at the electric lighting station. He states that if 3d. per unit is paid to the Lighting Committee, the lighting undertaking would yield an additional profit of £500 per annum. The car miles travelled on the lines suggested are estimated at 200,000 per annum, and at 11d. per car mile an income of £9,166 is reckoned, and after deducting the working expenses (6d. per car mile), interest, and repayment of capital, and allowing for depreciation and renewal, a profit of £566 is left. The Borough Surveyor says:—"In the construction of the line, I would advise you that if the works are carried out by yourselves they would be better done, that in working they would be more under your control than would be possible if they were undertaken by a company, and the cost of their construction would be from 20 to 25 per cent. less than they would be carried out by any syndicate or company doing them equally well and having the usual amount of promotion money to pay. You have also the great advantage of being able to borrow money at 3 per cent., and although I do not expect you to work the lines as cheaply as a company, in consequence of the fact that you would have to employ your men a shorter number of hours, and perhaps pay a slightly larger wage than a company would do, I am of opinion that this would be fully met by the reduction in first cost. My recommendations are that you should apply to Parliament for power to carry out the whole scheme as shown by the four colours on the plan, at a cost of £36,000, but that you only carry out at first the schemes lettered A, B and C, at a cost of £29,000. The car miles travelled on these lines would be not less than 180,000 per annum, and would yield at 11d. an income of £8,250," and after deducting expenses, interest, &c., there would be a profit of £850. In an appendix the following table, apparently taken from H. Scholey's book on "Electric Tramways and Railways," is given, showing the cost per car mile in horse, steam, and electric traction in various places:—

	Cost per car mile.	Percentage of expenses to receipts.
STEAM.		
Dudley and Stourbridge	12·40d.	75·87
Burnley	12·43d.	63·05
Huddersfield	14·00d.	88·80
Geneva	6·20d.	...
HORSES		
Plymouth	12·15d.	104·88
Lancaster	12·79d.	76·03
Leicester	10·11d.	83·37
Northampton	6·49d.	65·31
Newcastle	10·84d.	84·30
Leamington	...	85·35
Geneva	5·13d.	...
Reading	9·34 1.	76·86
ELECTRICITY.		
Leeds	5·5d.	...
Montreal	5·03d.	...
North Chicago	5·41d.	48·71
New London (Connect.)	7·26d.	...
Hartford "	4·75d.	...
Hanover	4·593d.	...
Hamburg	3·972d.	48·0
Zurich	5·001d.	...
Geneva	3·947d.	...

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
West Indies—		
Puerto Plata-Martinique	Dec. 19th, 1895 ...	...
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Jamaica-Colon	Feb. 6th, 1897 ...	...
Grenada-Trinidad ...	June 2nd, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Lourenço Marques-Durban ...	May 29th, 1897 ...	June 6th, 1897.
LANDLINES.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Siberian Lines:—		
Werkhne-Oudinsk-Tehita	June 1st, 1897 ...	June 4th, 1897.
Saigon-Bangkok... ...	June 4th, 1897 ...	June 5th, 1897.

April 19th, 1897.—Chio-Syra route impracticable.

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *vid* Bosnia, Montenegro and Servia.

The Ottoman Government announces that messages in secret language may not be sent to the Greek Minister and Consul in Turkey. They are to be in plain language.

April 21st, 1897. — The Greek Administration prohibits secret language for private telegrams for Greece.

April 25th, 1897.—The Hellenic Administration notifies delay on press messages emanating from Greek provinces by reason of the lines being blocked.

May 26th, 1897.—The Ottoman Administration notifies that, until further notice, private telegrams for Crete must be written only in plain Turkish or French language.

June 3rd, 1897.—During the interruption of communication with Trinidad and Demerara telegrams are sent by hired boat. Delay about 24 hours.

South African Cable Subsidies.—Mr. J. A. Ellis, the secretary of the Cape Town Chamber of Commerce, writes to the *Times* as follows:—"The attention of the Chamber having been called to a cablegram appearing in the Cape papers, under date London, April 20th, in which Dr. Leyds, when interviewed in Paris, stated, 'The Transvaal paid an annual subsidy of £10,000 to the cable company, which was in excess of the subsidy which the British Government itself allowed,' the Chamber think it necessary to submit to you the following facts:—There is at the present time an agreement with the cable company, which has been in existence since 1879 and which expires on December 31st, 1899; under that agreement the company receives the following annual subsidies:—Great Britain, £35,000; Cape Colony, £15,000; Natal, £5,000; Portugal, £5,000. In 1895 the Transvaal Government entered into an agreement with the cable company under which they undertook to give an annual subsidy of £10,000 for a period of 15 years. Under a further agreement, made in 1895, the Imperial Government, Cape Colony, Natal, and the Chartered Company agree to contribute the following amounts for a period of 10 years from the expiry of the existing agreement on December 31st, 1899.—Great Britain, £8,750; Cape Colony, £6,000; Natal, £1,650; Chartered Company, £600. You will perceive from the above that the Transvaal State Secretary only gave a very one-sided version of the facts of the case."

Telephony in Porto Rico.—According to a report to the Foreign Office on the trade of Porto Rico from Consul Crawford, it appears that the telephone systems of San Juan, Ponce and Mayaguez have been recently contracted for by local syndicates. A company was formed in this city with the object of presenting tenders for the telephone systems at Ponce, Mayaguez and San Juan. They obtained the concession for San Juan and Mayaguez, but at Ponce another tender was accepted. An American company obtained the contract for the material, and there are 100 stations already connected and in operation in this city, and it is expected that in another month 200 more will be in operation.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—July 2nd. Tenders are being invited until July 2nd next, by the Municipal Authorities of Ghent, for the establishment of an electric tramway in the town. Particulars may be had from the Secretariat, while tenders are to be sent to Le Collège Echivinal, Ghent.

Blackpool.—June 18th. The Corporation invite tenders for the supply, up to March 31st, 1898, of about 60,000 carbons of various measurements, &c. Borough Electrical Engineer, Mr. R. C. Quin.

Blackpool. — June 21st. The Corporation Electric Lighting and Tramways Committee want tenders for the supply of two bogie tramcars. Particulars from Mr. J. Lancaster, Manager, Tramways Depôt, Blundell Street, Blackpool.

Brazil.—June 30th. Tenders are being invited until June 30th next by the Municipal Authorities of Rio de Janeiro for the establishment of a telephone exchange in the city. Particulars of the contract were published in *Daily Tenders and Contracts* for May 6th.

Brighton.—June 14th. Tenders are wanted for the completion of the electric light wiring, &c., of the Municipal School of Science and Technology, Richmond Terrace, Brighton, for the Council. Particulars obtained at the office of Mr. Francis J. Tillstone, Town Clerk, Town Hall, Brighton.

Chili.—June 19th. The General Direction of the Chilian Telegraphs in Santiago is inviting tenders for the supply of a quantity of galvanised iron wire, insulators, Morse telegraph apparatus, &c.

Denbigh.—June 12th. Tenders are invited for the supply of complete electric light installation, for the North Wales Counties Asylum, Denbigh, including engine, dynamo, batteries and wiring, for lighting new temporary buildings at the Asylum. Particulars from the Clerk to the Visitors, or Mr. Thos. L. Miller, M.I.C.E., 7, Tower Buildings, Water Street, Liverpool.

France.—June 23rd. Tenders are being invited until June 23rd, by the Prefectural Authorities of the Rhône at Lyons, for an installation of electric lighting in the Bron Asile d'Aliénés. Tenders to be sent to the Préfecture du Rhône, Lyons.

Halifax.—June 21st. The Corporation want tenders for the supply of generators and motor generators, accumulators, and electrical equipment of cars for the proposed electric tramways. Borough Electrical Engineer, Mr. T. P. Wilmshurst.

London.—June 23rd. The Metropolitan Asylums Board want tenders for lighting by electricity the Grove Hospital, Tooting Grove. Particulars from the architect, Mr. A. Hessell Tiltman, 6, John Street, Bedford Row, W.C.

Neath.—June 28th. The Neath Corporation are inviting tenders for the working, by horse or mechanical traction, of the existing line of tramways. See our last week's "Traction Notes."

Roumania.—August 20th. Tenders are being invited by the General Direction of the Roumanian Posts and Telegraphs in Bucharest for the supply of 55,000 porcelain (double-bell) insulators. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, Bucharest.

Southampton.—June 16th. The Corporation wants tenders for the supply and erection of water-tube boilers, mechanical stokers, coal conveyor, pump, steam and water mains, water tank, water purifier, fuel economiser, and ironwork. Engineers, Messrs. Kincaid, Waller & Manville.

Spain.—June 19th. Tenders are being invited by the Municipal Authorities of Valdepenas (Cuidad Real province) for the concession for the electric lighting of the town. Tenders to be sent to El Secretario del Ayuntamiento, Valdepena (Cuidad Real).

Sydney (New South Wales).—Tenders are wanted for four duplicate sets of engines and dynamos capable of running 2,000, 4,000 and 5,000 lights each, landed and erected in Sydney. These are required for lighting a large block of buildings, including the Hotel Agincourt, that have been erected for Mr. Henry Goodwin, who is now staying at Anderton's Hotel, Fleet Street, London, E.C. Particulars can be obtained from Mr. Goodwin at that address.

Treeton.—June 24th. The Treeton (near Rotherham) Parish Council want offers for:—(1) a contract for the supplying and fixing plant, apparatus, and materials for lighting certain streets and roads in the parish of Treeton by means of electricity; and (2) a contract for the supplying electricity for 1,000 hours per annum, and working, repairing, and renewing the plant for 30 years. Clerk to the Council, Mr. S. Fiske.

CLOSED.

Belfast.—The Electric Committee has accepted the following tenders in connection with the electric lighting extensions:—

Boilers and economisers:—	Victor Coates & Co., Ltd.
Storage battery, supply and maintenance and exchange of the present battery for one of another type.	Electrical Power Storage Co.
Earthenware conduits and junction boxes	Doulton & Co.
Cables, supply and laying, also road work.	Callender's Cable & Construction Co.
Cast-iron work:—	John Shaw & Co.
Piling site of proposed station:—	J. & W. Stewart.

Leeds.—The City Council has accepted the tender of Mr. William Wharam for the supply and erection of arc lamps, conductors, &c., for street lighting in connection with the electric tramways at a cost of £988 10s.

Sunderland.—Messrs. J. H. Holmes & Company have received an order from the Corporation for a Holmes dynamo and a Belliss engine for the Corporation electric lighting station.

NOTES.

The Aluminium Works at Foyers—We have rather an important correction to make to the article on the Aluminium Works at Foyers which recently appeared in these columns, and that is Mr. R. W. Peregrine Birch was the engineer for the construction work, and after his death he was succeeded by Mr. H. Vaux Graham, who was resident engineer under Mr. Birch.

Marriage.—We offer our good wishes to Mr. Frank Bailey, A.M.I.C.E., who was married at Holy Trinity, Micklegate, York, on 3rd inst., to Mary Katherine Elliott Metcalfe. The honeymoon is being spent in Scotland.

Preservation of Meat by Electricity.—A process of preserving meat by electricity has been invented by a Mr. Pinto, of Rio Janeiro, and has been already referred to in these columns. In the ordinary process of pickling meat, it must be left for a considerable time in the pickling solution, to give the pickle sufficient time to penetrate to the interior of the mass. It is this process of saturation which Pinto has succeeded in accelerating by means of the electric current. The experiments of Dr. Gärtner have shown that substances in solution can, when ordinary methods fail, be forced through porous bodies, and even through the skins of animals, by the electrolytic action of the electric current. He has used this method to introduce medicines into the body, when the stomach was not available. It is by means of a similar process of electric transfusion that the time required for tanning of skins has in recent years been considerably reduced. Pinto's new pickling process is another application of this well-known property of the electric current. The meat is placed in a bath of brine, and a current of about 100 amperes sent through by an E.M.F. of 8 volts; 3 litres of brine are used for each kilogramme of meat. Electrodes of platinum must be used to prevent the possibility of poisonous salts getting into the bath. The electric pickling process takes from 10 to 20 hours. This process is evidently much simpler and more effective than other processes of rapid pickling, such as the injection of brine by syringes, and deserves the attention of all who are interested in preservation of food stuffs.

The Beltless Age.—In a recent article in the *American Machinist*, Mr. A. M. Lozier, M.E., of the Bullock Electric Manufacturing Company, says: "When electrical transmission stepped to the fore, even the best equipped factories presented a most inconsistent appearance. Their condition might be compared to two strong iron links of a chain held together by a piece of string, for on the one hand their boilers and engines were of the best and most economical types, and on the other hand, their tools or printing presses were compact, automatic and highly efficient. But the connecting link, the means of transmitting the power from the engine to the tool, was a weak one, a great source of waste in power and a relic of conservatism. It is astounding that for years, thousands (indeed, one may say millions) of horse-power-hours have been wasted in the mere friction load of shafting and belting, without any serious consideration of the matter by mill owners and printers. Records of tests made in over 200 representative factories and printing establishments of this country alone show, as an average, that about 50 per cent. of all the power generated by the engines has been wasted in belt or rope transmission of power."

"The Rivalry between Gas and Electricity."—Under this title, a "Gas Director" communicates to our contemporary, the *Gas World*, some reasonable statements concerning the position of the two illuminants. It is a fact that has been repeatedly commented upon in these columns, that the supply of gas goes on increasing despite the growing popularity of electric lighting. The reasons put forward for this curious state of things are familiar to all, and it is hardly necessary to repeat them. On some future occasion, perhaps, we may be able to learn how far the increased consumption of gas is dependent on stoves and other heating apparatus. For the present, however, we will remain content with publishing figures relating to the quantity of gas and electricity sold in four large towns. It is necessary to mention that the figures do not cover quite the same periods but they are sufficiently near to illustrate the increased consumption of gas and electricity.

	Gas.		Electricity.
Bradford.			
1895.	1,440,128,000 feet.	1895.	673,699 units.
1896.	1,608,862,000 feet.	1896.	813,623 units.
Brighton.			
1895.	895,996,000 feet.	1895.	867,494 units.
1896.	954,113,200 feet.	1896.	1,388,821 units.
Edinburgh.			
1895.	1,212,718,000 feet.	1895.	888,335 units.
1896.	1,357,000,000 feet.	1896.	1,723,960 units.
Manchester.			
1895.	3,579,433,000 feet.	1895.	1,748,244 units.
1896.	3,646,010,000 feet.	1896.	2,721,922 units.

Dinner to Mr. Webb.—At the Whitehall Club, on Monday, 14th inst., Lord Kelvin will preside at a dinner in honour of Mr. F. H. Webb, the retiring secretary of the Institution of Electrical Engineers.

Street Railway Convention.—The American Street Railway Association is to meet at Niagara Falls in October, and this year's assembly will doubtless witness the attendance of even more English and Continental visitors than was the case last year. Indeed, this interchange of national views and opinions is rapidly increasing, and should tend more than ever to a mutual good understanding. We speak on this side (especially during the present jubilation) of the American invasion, but what with visitors from our shores to the National Electric Light Convention, the street railway meeting above named, and the British Association (which is to find a home this year in Toronto) it may fairly be said that we send almost as many visitors as we receive, under ordinary conditions. The Street Railway men have already got their programme filled with good subjects to talk about and give others the benefit of experience. Unlike our own dearly-beloved even though somewhat antiquated Tramway Institute, the discussions will not deal with horse feed, car starters, and inventors' notions generally, but are to embrace topics like municipal ownership of tramways, the use of gas engines in power houses, and long distance transmission. Possibly before the present generation passes away, we shall be able to chronicle the proceedings on this side of a similarly active and energetic association; but the dreadful inertia of our local authorities and tramway companies makes us fear such an amount of progress to be very doubtful.

Freaks of Lightning.—C. H. Latta, writing to the *American Electrician*, says:—"I happened to be in a station one day last summer when a heavy thunderstorm was going on. The station in question runs both an electric railway and incandescent lights, and it is customary to shut down the machines during a storm, the circuit breakers, feeder and dynamo switches being opened, but the generators left running. On the occasion referred to a flash of lightning burned out both generators simultaneously. Perhaps some of your readers can explain how the generators burned out, there having been no connection whatever with the lines."

Obituary.—We regret to hear of the death of Mr. C. W. Earle, who was thrown from his bicycle on Monday and killed on the spot. Mr. Earle, who was 68 years of age, joined the 60th Rifles in 1846, in which regiment he served in South Africa under General Sir George Cathcart, to whose staff he was appointed, in all the engagements which took place during the Kaffir wars of 1851-52. He went to India and served throughout the Indian Mutiny. He held for four years the appointment of Deputy-Judge-Advocate-General for the Rohilkhand district. In 1864 he retired from the Army, and since then has been connected with several telegraph companies. He was chairman of the West India and Panama Telegraph Company, and director of the Eastern Extension and the Western and Brazilian Telegraph Companies. His familiar face will be missed from the meetings of these companies.

Experiments on Superheated Steam.—Some recent experiments made with a triple expansion engine by M.M. Meunier and Ludwig had for object the ascertainment of economy due to superheating steam at 12 atmospheres pressure. The cylinders were respectively 22 inches, 31½ inches and 45 inches diameter × 4½ feet stroke, and the revolutions were 70. With a separately heated Uhler heater, which only heated the steam to 228° C. at the engine, the economy was 14 per cent. of steam and 5 per cent. of coal. The actual heat was 251° at the heater, or 62° C. of superheat; but 22° were lost before the steam entered the engine, at which point there were ramaining 40° only. Changed to a Schwœrer apparatus with 2,743 feet of surface, the steam economy was 14·7 per cent. and the coal economy 18·4 per cent., the superheat being 100° C. at the heater, and a loss of only 13° occurred between that and the boiler. Without superheat, the oil used in 11 hours was 8·8 lb.; with superheat, it was 11·7 lb. for a more expensive oil. It is plain that the increased surface from 1,635 feet to 2,743 is to be credited with some of the improvement, but the coal economy is clearly due to the fact that the Schwœrer heater is placed in the boiler while the Uhler is separately heated. The change of superheat from 40° to 66° only resulted in reducing the steam consumption by 0·2 of a pound, which would seem to show that the value of superheat is largely secured with moderate degrees only, 40° C. corresponding with 72° F., only, the higher superheat of 119° F. giving so little additional economy. We are indebted to the *Proceedings* Inst.C.E. for the figures of this note. We had thought the economy of superheating was long ago settled as regards mere instant economy, and that the only question now was one of commercial expediency in regard to oil consumption and cylinder wear.

Presentation.—Last Saturday the staff and workmen of the Sheffield Electric Light and Power Company, Limited, assembled at the Prince of Wales Hotel, to wish Mr. T. E. Donoghue (who has been with the company 9 years) prosperity in his new position with the South Shields Corporation. Mr. Donoghue was presented with a small library of electrical books and a micrometer.

Appointments Vacant.—Applications are invited for the following posts at the Northampton Institute, Principal, Dr. R. Mullineux Walmsley :—Senior demonstrator in applied physics, physical demonstrator and assistant mechanic, lecturer and instructor in electro-deposition, lecturer and instructor in electrotyping and stereotyping, instructor in ornamental smith work, instructor in decorative metal work. See our "Official Notices" for further details.

The Edinburgh Corporation want an assistant engineer for the electric light station, at £100 per annum. See our "Official Notices."

Utilisation of Water-Power in Spain.—A company is reported to be in course of formation at Santander for the purpose of putting down plant to utilise certain available water power of the River Ason, in the generation of electrical energy for lighting and power purposes.

Sir David Salomon's Installation at Broomhill.—A well illustrated and interesting article from the pen of the owner of Broomhill, Tunbridge Wells, appears in the May issue of the *American Electrician*, describing the very complete electrical installation which Sir David has put down there. It will probably be a surprise to many of our readers to know that as much as half a million dollars has been expended upon this installation, the workshops, laboratory apparatus, &c., &c.

CITY NOTES.

The Portsmouth Corporation Accounts.

The electricity works at Portsmouth, from the commencement of their operations, have been distinguished for their low working costs, and now that the output has been more than doubled, and with the excellent management of Mr. Price, one naturally expects to see the cost of production diminishing. It will be seen from the subjoined figures that such is the case. After meeting interest on redeemable stock and mortgage debt (£2,614), and transferring £1,931 to loans fund, there is practically a balance of £2,000 on the year's working, which is a state of things that reflects credit on the management.

The following table gives the cost per unit :—

	1896.	1895.
Total capital expended	£99,744	£91,256
Number of units sold	839,392	406,118
Number of lamps connected ...	—	—
Revenue from sale of current ...	£13,699	£7,000
Net revenue	£6,870	£3,300
Average price obtained per unit ...	3·9d.*	4·1d.

* Public and private lighting.

Cost of Production.	£		Per unit.	1895.
Coal	1,969		·56d.	·67d.
Oil, waste, water, and engine room stores	521		·15d.	·16d.
Salaries and wages at generating station	790		·22d.	·40d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	1,373	Works' cost 1·32d.	·39d.	·28d.
Rates and taxes	316		·09d.	·11d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	1,038		·30d.	·43d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£6,006		1·71d.	2·05d.
Not included in the above.				
Cost of materials and lamps sold as per contra	130			
Attending and repairing public lamps	1,128			
Interest on overdraft	151			
Total				

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	13,699	0	0	3·9d.
Meter rents	273	0	0	—
Sale of Lamps	298	0	0	—
Total	£14,270	0	0	3·9d.

Total cost per unit (exclusive of depreciation and renewal accounts), 1·71d.; works' cost, 1·32d.

Nottingham Corporation Accounts.

Last year, in speaking of the accounts of the Nottingham Corporation Electricity Works, we had to chronicle a deficit of £2,234, but as we then pointed out this was in a great measure due to certain expenses that had accrued before the opening of the works. The result of last year's working are eminently satisfactory, for in addition to wiping off the deficit of £2,284, £1,538 is applied as interest on consolidated stock and loan, £356 goes as a contribution to sinking fund, and £452 is carried to a reserve fund to provide against depreciation of buildings, machinery, &c. We are glad to see that provision is to be made out of revenue for depreciation, for in spite of the arguments put forward by many members of municipal authorities, we hold that some such fund should be established.

The following table gives the cost per unit :—

	1896.	1895.
Total capital expended	£72,265	£53,720
Number of units sold	297,185	171,654
Number of lamps connected	—	15,419
Revenue from sale of current	£7,057	£4,123
Net revenue	£4,632	£2,309
Average price obtained per unit... ...	—	5·7d.

Cost of production.	£		Per unit.	1895.
Coal	703		·57d.	·60d.
Oil, waste, water and engine room stores	153		·12d.	·15d.
Salaries and wages at generating station	490		·39d.	·53d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	255	Works' cost 1·29d.	·21d.	·37d.
Rates and taxes	239		·19d.	·07d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	809		·65d.	1·08d.
Depreciation of buildings and plant account	—		—	—
Renewal und account	—		—	—
Total	£2,649		2·13d.	2·80d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	7,057	0	0	
Meter rents, &c.	237	0	0	
Other tems	67	0	0	
Total	£7,361	0	0	

Total cost per unit (exclusive of depreciation and renewal accounts), 2 13d.; works' cost, 1·29d.

The Consolidated Telephone Construction and Manufacturing Company, Limited.

The report of the directors presented at the sixteenth annual general meeting of the company held yesterday at Winchester House, Old Broad Street, stated that the total receipts for the year on revenue account amount to £4,404 17s. 2d., including £1,000 paid by the Edison Gower-Bell Telephone Company of Europe, Limited, on account of dividends already declared. Deducting the usual expenses, amounting to £2,122 9s. 1d., and including the amount brought forward from last year, a balance is left of £3,684 15s. 8d., against which your directors have decided to write off a total of £506 15s. 1d.[1] as detailed in the revenue account. This will leave a net sum available of £3,178 0s. 7d., out of which the directors propose to pay a dividend of £2 per cent. (less income tax), carrying a balance forward of £1,004 9s. 7d. The removal of the works to the provinces has, as the directors anticipated, proved a success in the saving of "manufacturing charges," though it is hoped that the saving in wages will be more pronounced when the demand for labour in the bicycle trade

has slackened. The total amount of sales exceeds that for some years past; the high character of the company's manufacture has been maintained; the plant is kept to an efficient point, and the stock is sufficient in quantity to supply orders forthwith. The enlargement of the company's powers, as approved by the shareholders in 1895, has enabled other work to be undertaken with satisfactory results, and the directors are hopeful that these new demands will increase. The rentals from private telephone lines increase and promise to continue, though the highest paying point of the lines already built and leased has not yet been reached. The removal of the subsidiary companies' offices to Shaftesbury Avenue (foreshadowed in last year's report) has been effected. The lawsuit in Belgium carried on by The Edison Gower-Bell Telephone Company of Europe is showing satisfactory progress; certain of the infringing companies seem disposed to compromise matters. The Anglo-Portuguese Telephone Company shows the following progress:—

YEAR ENDING MARCH 31ST.

Subscribers.		Rental.		Increase.	
1896.	1897.	1896.	1897.	Subscribers.	Rental.
2,494	2,537	£16,408	£16,863	43	£455

In accordance with the articles of association, Mr. Henry Grëwing retires by rotation, and being eligible offers himself for re-election. The auditor, M. J. G. Griffiths, F.C.A. (Messrs. Deloitte, Dever, Griffiths & Co.) also retires, and offers himself for re-election.

The annual general meeting of the company was held at Winchester House yesterday.

Mr. C. L. W. FITZGERALD, who presided, said he could congratulate the shareholders on two things: moving the works into the country, which had saved a good deal of money, and upon the increased sales, which had amounted to a good deal more than those of the past few years. Their profit on trading last year was £1,176, and this year they stood at £2,021, a state of things which they hoped would continue. The expenses had increased by £100, mainly due to office expenses, which in future would be reduced on account of the subsidiary companies being located in the same offices. They had spent £586 on plant, but this was only £100 more than last year. They had added to the land and buildings at Coventry, and had made additional sheds. They had reduced the debtors of the company from £6,140 last year to £2,765, and another feature was, that their subsidiary companies only owed them £420 instead of £4,513 last year, although they had been extending their connection with other companies. The enlargement of the company's powers had enabled other work to be undertaken with satisfactory results. Their subsidiary telephone company had again increased its business, and showed an increase in rentals of £455. Mr. Stoope, had communicated with some of the shareholders, but he (the chairman) thought it would be better if he met the Board to confer with them, for they had found that discussions did not do them any good. Altogether the receipts for the year were £4,404, and the amount left available for division was £3,178; of this amount they proposed to pay a dividend of 2 per cent., and carry forward a balance of £1,004.

A SHAREHOLDER said that there was no trading account giving the expenses of such trade.

Mr. STOOPE said he did not want to do anything unfriendly to the board, but his point was that there was an increase in the manufacturing expenses. The profits were largely derived from the investment part of the business, and he maintained that if they had only had the investment business, they could have paid larger dividends.

After some further remarks from the speaker, the CHAIRMAN put the adoption of the report to the meeting, which was carried.

Mr. STOOPE asked for further information as to the prospects, and

Mr. MENZIES, the general manager, pointed out the past difficulties of the company in getting orders for telephones, and the small profits due to their competitors cutting them out. Their prospects were no worse than they had been for many years; in fact they were slightly better.

Mr. STOOPE expressed his dissatisfaction with the remarks of the general manager, and proposed a resolution to the effect that the time had come to propose the voluntary liquidation of the company.

The SOLICITOR of the company pointed out that such a resolution would be out of order, it not being ordinary business.

The re-election of the retiring director and auditor concluded the business of the meeting.

The Apostoloff Automatic Telephone Parent Syndicate.

AN extraordinary general meeting of this company was held at Winchester House, on Friday last, for the purpose of considering a proposal to transfer the business of the syndicate to a new company. The terms of the proposal have been already referred to in these columns.

Mr. MAX MARGOWSKI, the managing director of the company, presided, and in his opening remarks pointed out the importance of the meeting. When Mr. Apostoloff first introduced the invention to him, he considered it good enough for him to provide the necessary capital without seeking outside help. He (the chairman) found the major portion of the capital, and £500 was provided by the Honduras Government Banking and Trading Company. At the statutory meeting he told those who had become shareholders that the invention might be worth £2,000,000 or 2d.; there was always a great deal of speculation and risk attached to anything of that kind. It was necessary to put Mr. Apostoloff's invention into a practical commercial form, and that had taken up a great deal of time, and they had not yet obtained all their patents. When the model was completed they invited experts to witness the working of the invention, and among them were the representatives of a certain great monopoly The price they asked for one patent was £500,000, and the basis of their calculation was 30 per cent. of the economy their system would produce to the monopoly. This monopoly was the only one in the world working with an underground system, and they asked the inventor for the solution of a certain problem; their inventor found a technical solution, but they wanted something more practical, and they had to find a gentleman to perfect the system. This gentleman was a well-known engineer, and stood next to Edison; he was occupying a principal position with one of the European Governments, and he had been satisfied to leave his position and sacrifice his claim to a pension to which he would be entitled in a few years. It became necessary, therefore, to form a larger company, with a capital of £100,000; £10,000 would be working capital, £5,000 would be left in the treasury for emergency, and £10,000 in fully-paid shares would be given to the gentleman who left his high Government position; he was not at liberty to mention his name. The remaining £75,000 would go to the syndicate, to be distributed *pro rata*. They were not selling their business to a new company, but practically to themselves. He (the chairman) was the largest holder in the syndicate, and, apart from his original holding, he had since bought shares at a premium of 1,300 per cent. He had not made further purchases, because he did not think it right to take advantage of the special knowledge he possessed of the importance of the invention. The £10,000 they required was divided into two portions, £5,000 to be deposited in the Bank of England for a guarantee of the remuneration they had to pay the high official, and £5,000 would be used for development purposes. In his opinion, his holding at the present moment was worth £250,000. He originally held 42 per cent. of the shares, but he was now a holder of 46 per cent.

At the conclusion of the chairman's speech many of the shareholders commented on the absence of accounts, while others dwelt on the ambiguous nature of the circular sent out.

The SECRETARY said that though the accounts had not been audited they were very simple. No salaries had been paid; the subscribed capital had been £3,500, and this had gone in payment of patent fees. £1,000 formed part of the purchase price, while further amounts had been found by the chairman.

Eventually, after a somewhat acrimonious and heated discussion, a committee of three shareholders was appointed to confer with the directors as to their proposals, and the meeting was adjourned for a week.

National Telephone Company, Limited.—The public have had before them during the past few days the prospectus of the National Telephone Company, offering for subscription 130,766 5 per cent. non-cumulative third preference shares of £5 each. These shares are the balance of 250,000 authorised. The shares are offered for subscription by tender, the minimum price being fixed at £5 15s. per share. The total authorised capital of the company is £6,000,000, of which £4,648,626 is already issued—namely, £150,000 6 per cent. first preference, and £150,000 6 per cent. second preference £10 shares, £596,170 third preference £5 shares, £2,422,985 £5 ordinary shares, and £1,329,471 in 3½ per cent. debenture stock. The new issue is made to provide the necessary capital required to meet the extension of the business. Tenders must be sent to Messrs. Robarts, Lubbock & Co., 15, Lombard Street, E.C., or the National Bank of Scotland, 37, Nicholas Lane, E.C., on or before 19th inst.

British India-Rubber and Exploration Company, Limited.—We understand that the directors of the British India-Rubber and Exploration Company, Limited, "having deemed it inexpedient to proceed to an allotment," announce that the money subscribed by applicants for shares and debentures will be returned in full.

National Electric Supply Company, Limited.—At an extraordinary general meeting of this company on Wednesday, last week, under the chairmanship of Mr. E. H. Booth, it was decided to reduce the issued capital from £51,750, divided into 10,950 £5 shares, of which 100 are founder's shares, and the remaining ordinary shares to £39,693 divided into 10,950 shares of £3 12s. 6d. each, of which 100 are to be founder's shares and the remaining ordinary shares, such a reduction to be effected by cancelling paid up capital to the extent of £1 7s. 6d.

Stock Exchange Notice.—The Committee has appointed Wednesday, June 16th, a special settling day in Callender's Cable and Construction Company, Limited, 20,000 shares, Nos. 1 to 20,000, and has ordered same to be quoted in the Official List.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending June 6th, 1897, were £915; week ending June 7th, 1896 £930; increase, £15; total receipts for half-year, 1897, £23,335; corresponding period, 1896, £21,465; increase, £1,870.

The Great Northern Telegraph Company. The receipts in May, 1897, were £24,000; January 1st to May 31st, 1897, £114,000; corresponding months, 1896, £114,000; corresponding months, 1895, £124,000.

The Liverpool Overhead Railway Company. The receipts for the week ending June 6th, 1897, amounted to £1,324; corresponding week last year, £1,152; increase, £172. (1897 includes Whit Sunday.)

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 4th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,225.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, June 2nd.	Closing Quotation, June 9th.	Business done during week ended June 9th, 1897. Highest.	Lowest
149,900	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	4 — 5	5 — 6	...	...
923,960	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	52 — 55	52 — 55	52	...
3,038,020	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	97 — 98	97 — 98	97⅜	97
3,038,920	Do. do. Defd.	Stock	..	..	...	9 — 9½	9 — 9½	9¼	...
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15 — 15¼	15 — 15½	$15\frac{7}{16}$	$15\frac{3}{16}$
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	114 —118	114 —118	117	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3¼ - 3⅜	3¼ - 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	173 —177	173 —177	...	...
400,000£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	102½—103½	103½—104½	104½	103½
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	⅛ — ⅛	⅛ — ⅛	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	9 — 10	9 — 10	9⅜	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ — 4½	3½ — 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9½ — 10½	9½ — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	105 —108%	105 —108 %	..	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	8⅜ — 9¼	9 — 9½	9⅛	$9\frac{1}{16}$
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	16⅜ — 17¼	17 — 17½	17¼	17
70,000	Do. 6 % Cum. Pref.	10	6 %	6	...	18 — 19	18 — 19	...	...
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	103 —106	103 —106	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	127 —130	127 —130	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7⅛	17⅜ — 18¼	17⅜ — 18¼	18	17⅜
35,500£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	101 —105	101 — 105	...	...
133,100£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	102 —105	102 —105	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	128 —131	128 —131	...	...
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	101 —105	101 —105	...	...
69,200£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	102 —105	102 —105	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	105 —108	105 —108	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	107 —110%	107 —110 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11¼ — 11⅝	11¼ — 11⅝	11½	11⅜
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	17 — 17½	17 — 17½	17⅛	17
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	10⅜	25 — 26	25 — 26	...	...
160,000	Do. do. do. 5 % Debs.	100	5 %	5 %	5⅜	103 —106	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10⅜	54 — 57	54 — 57	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	107	106
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2¼	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5¼%	6⅝ — 6⅞	6⅝ — 6⅞	$6\frac{13}{16}$	6⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	16¼	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	...	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3¼%	105 —109	105 —109	106	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	⅝ — ¾	⅝ — ¾	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	*nil*	5 %	5 %	7 — 8	7 — 8	7½	...
3,381	Submarine Cables Trust	Cert.	...	...	...	135 —140	135 —140	...	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3½ — 4	3½ — 4	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	4 %	nil	5 — 6	5 — 6	...	...
213,400	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	101 —104	101 —104	...	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	...	... — ...	... ...	...	...
150,000	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	... — ...	... ...	...	...
64,256	Western and Brazilian Teleg., Ltd.	15	8 %	3 %	2 %	7⅜ — 8¼	8 — 8¼	8¼	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½ — 7	6½ — 7	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	1⅜ — 2¼	1⅜ — 2¼	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	1 %	⅜ — 1⅛xd	⅞ — 1⅛	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10½ — 11 xd	10½ — 11	...	...
14,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9 — 10 xd	9 — 10	10½	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7%	104 — 108	104 —108	...	...
162,200£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply ..	5	4½%	5 %	6 %	13½ — 14½	13½ — 14½	$13\frac{9}{16}$	...
20,000	Do. do. do. 4½ % Cum. Pref.	5	...	...	...	6½ — 6⅝	6½ — 6⅝	...	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	9⅞—10¼	9½ — 10	$9\frac{15}{16}$	9⅞
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	112 —115	112 —115	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	23½ — 24½	23½ — 24½	24½	23⅝
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 — 18	17 — 18	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —136	131 —136	132	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	*nil*	*nil*	12⅜ — 13½	12⅜ — 13½	13½	$12\frac{13}{16}$
10,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	6 %	6 %	15 — 15½	15 — 15½	15½	$15\frac{1}{16}$
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	..	14⅜ -- 15½	14⅜ — 15½	$14\frac{15}{16}$	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	8½ — 9½	8¼ — 9	8⅜	$8\frac{1}{16}$
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	16½ — 17½	16½ — 17½	$17\frac{1}{16}$	17
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	13½ — 14½	13½ — 14½	...	...
220,000	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	120 —124	120 —124	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	15 — 16	15 — 16	15½	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	15½ — 16½	15½ — 16½	16⅜	15⅞
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	5 %	7 %	9 %	15 — 16	14½ — 15½	$1\frac{13}{16}$	1⅞

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.
¶ Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, June 2nd.	Closing Quotation June 9th.	Business done during week ended June 9th, 1897. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	£	2½%	...	...	1⅛ — 1⅜	1⅛ — 1⅜	1⅝	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	£	3 %	...	...	1½ — 1⅝	1½ — 1⅝	...	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	104 —108	104 —108	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	95 — 99	95 — 99	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9¾ — 10¼	9¾ — 10¼	10	...
143,105	Do. do. do. £6 paid	10	...	...	...	5½ — 6¼	5½ — 6¼	6	5 13/16
51,951	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 1⅝	1½ — 1⅝	...	...
54,521	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼ — 4⅜	4¼ — 4⅜	...	...
630,000£	City and South London Railway	Stock	1⅛%	1 1/16%	1 1/16%	58 — 60	58 — 60	59⅜	59⅛
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	£	*nil*	*nil*	...	1⅜ - 2¼	1⅜ - 2¼	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	£	5 %	5 %	...	2 — 2¼	2 — 2¼	2 5/16	2⅛
17,139	Do. do. do. "A" Shares 01—017,139	£	5 %	5 %	...	3½ — 4½	3½ — 4½	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	4½%	4½%	...	105 —110	105 —110	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	£	*nil*	5 %	...	1⅝ — 1⅞	1⅝ — 1⅞	...	...
16,343	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	£	7 %	7 %	...	2⅝ — 3½	2⅝ — 3½	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	£	*nil*	...	...	¾ - 1	¾ — 1	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	£	*nil*	...	...	¼ — ½	¼ — ½	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	£	*nil*	10½%	.	11 — 13	11 — 13	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	£	6 %	8 %	10 %	18 — 19	18½ - 19½	19¼	18⅞
3,000	Do. do. do. 7% Pref.	£	7 %	7 %	7 %	18½ — 19½	18½ - 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	108 —113	108 —113	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	£	10 %	10 %	10 %	20½ - 21½	20½ — 21½	21 3/16	21
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	104 —107	104 —107	...	...
37,500	†Liverpool Overhead Railway, Ord.	£	1½%	2⅝%	2⅝%	21⅞ 12 13/16	12⅝ - 12⅞	...	..
10,000	† Do. do. Pref., £10 paid	£	5 %	5 %	5 %	15½ - 16	15½ — 16	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	£	20 %	15 %	15 %	35 — 38	36 — 37	38	36
150,000£	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	103 —106	103 —106	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅜ — 11¼	10⅜ — 11¼	10⅞	...

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50 % for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7½%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9¼.
British Electric Traction, 12¼—12⅝.
Electric Construction Corporation, 6 % Debentures, 105—107.
House-to-House Company, 7 % Preference, of £5, 9⅝—10¼.
Do. do. 4½% Debentures of £100, 109—111.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 12½—13½; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.
London Electric Supply Corporation, £5 Ordinary, 1⅜—2¼.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8¼—8¾. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount, 2 per cent. (May 13th, 1897).

PROFITABLE EXTENSIONS OF ELECTRICITY SUPPLY STATIONS.*

By ARTHUR WRIGHT, Borough Electrical Engineer, Brighton.

PERHAPS it may appear rather bold for an Englishman to present a paper on a subject relating to central supply stations in a country from which—as we all acknowledge—came the first real impetus to practical electricity supply, but it seemed by so doing that the managers of some of the American stations, in discussing the conclusions which experience has led the author to believe are sound, might throw some fresh light on one of the most vital questions we all have to meet. If, owing to his ignorance of the conditions under which electricity has to be supplied on the continent of America, he has made some mistakes of detail, he trusts the members will overlook them so far as they do not vitally affect the main principles on which their criticism is invited.

There are many central stations which, very soon after commencing business, have to face the call for extensions of plant and mains, and generally this necessity has been regarded as an unmistakable proof of commercial success. Many of us have found that this is not necessarily the case, and it is certainly obvious that no extensions are warrantable unless a definite profit can be assured from them.

Notwithstanding the common impression that it is necessary in the electricity supply business to take the bad customers with the good, the author maintains that no company should be called upon to supply electricity to anyone at a loss, and he hopes to show that it is quite possible to devise as simple and equitable tariff by which a profit is assured from each and every consumer, and moreover, that it is only by adopting such a tariff of approximately *equal rates of profit* from all, that managers can hope to bring electricity into general use for every one of the manifold purposes to which it is adapted. He also hopes to show that an enormously extended business in electricity supply can be done among an ever-increasing number of consumers at rates which in most cases will successfully compete with gas while all the time yielding substantial profits. The prevailing idea among central station managers seems to have been that, in competition with other illuminants, electricity must rely upon its superiority in cleanliness, convenience, and healthiness. It can, however, be shown that in one of the richest fields open to central supply stations electricity can compete with its rivals right on the basis of price.

Owing to the great development of the business of electricity supply for power transmission, for traction, and for other purposes, many station managers have lately devoted most of their attention to the demand from these sources, and have apparently assumed that they have already substantially secured the greater part of the lighting business they are likely to get in their districts. The author, on the contrary, firmly believes that even a larger and more fruitful field for electricity supply still exists in every town, waiting only to be cultivated—the field of domestic lighting. Thousands of lamps are required in the homes of the great middle and lower middle classes that form the staple of our populations. In these homes, too, artificial light is used for several hours daily all the year round; that is, under conditions so favourable to the central station manager that he can in most cases supply electricity at a price that, while remunerative, compares favourably with the cost of gas. This profitable domestic supply, which is mostly on duty after business hours, need not interfere with the much-catered-for power supply, the value of which one must, of course, fully appreciate.

Another great field for profitable extensions is to be found in the smaller classes of stores, saloons, and business houses which trade until late in the evening. As this class of consumers frequently live over their business premises, their use of artificial light is a very lengthy one, so, although their bills may be small, they can be supplied at a rate which, while low enough to secure the business, leaves such a substantial profit as to far more than counterbalance the cost of connection and collection with such classes.

Managers are now seeking fresh markets and uses for electricity supply, neglecting the domestic lighting field, which has hardly yet been touched. This, the author considers, is mainly due to the habit which has been acquired of regarding consumers *collectively* instead of *individually*, and estimating the cost of supplying any one class to be the average cost of supplying all classes. Thus it has been generally overlooked that it is quite possible to derive more profit from the supply of electricity to small long-hour consumers at a low rate than from the supply to large consumers, such as big stores, &c., at a much higher rate.

The author doubts the possibility of much financial success attending the efforts of station managers until they dismiss from their minds the idea that large consumers' bills necessarily mean large profits. Very frequently the reverse is the case. Although it seems a mere platitude to say that a small business with a large profit is better than a large business with a small profit; yet this does not appear to have been realised generally, if we are to judge by the heavy discounts often given off large accounts irrespective of whether the conditions under which their electricity has been supplied has yielded a profit or a loss, while little if any inducement has been held out to the small consumer, requiring light for long hours, to encourage him to use electricity for lighting purposes.

* Read before the National Electric Light Association, Niagara Falls, June 9th.

The author trusts it will not be supposed that because he has expressed such a keen appreciation of the small but long-hour consumer, that he does not sufficiently value the large consumer having the same qualification. His contention is that if an equal rate of profit be charged impartially to all consumers, whatever be their class or size, the field for profitable extensions is almost boundless.

In this paper the writer has endeavoured to confine himself to the commercial considerations which govern the profitable extension of supply stations. He is firmly of the opinion that while engineers have been devoting a vast amount of time and energy to considerations of coal and plant economy, they have neglected the readiest of all means for reducing the cost of supplying the electricity, viz., such an adjustment of the tariff as to offer great inducements to the profit-yielding consumers, and ensure that the unprofitable ones shall be charged at as high a rate as is possible or expedient; a tariff, in fact, that will broaden out the average load curve of the station, and so increase the usefulness of the investment.

In large stations the questions of coal economy are matters of great importance, but from the very nature of things the paramount consideration must always be the adjustment of the tariff so as to attract the most profitable classes of consumers. The cost of the raw materials of electricity supply, viz., coal, water, and stores, have in many stations been brought down to a little over 1 cent per kilowatt-hour, and all the resources of engineering, so far as we now know them, can only help us to make a fractional improvement on that small figure.

It may be argued that if the principle of *equal rates of profit* from all consumers were carried into effect, it might result in a serious loss of revenue to the supply stations, owing to the large but short-hour consumers objecting to the incidence of the charges upon them. In practice, such a contingency need not be feared, as consumers of the type indicated are generally unable to dispense with electricity, or are well able to pay a comparatively high price for the luxury of having at command the best light procurable at irregular intervals or for a short time each day. Moreover, any consumer discontinuing his supply because he was charged at a higher rate than his neighbours would not necessarily be a loss to the supply company. Unless, indeed, he is a source of profit, the plant allocated to his wants could be better employed. In fact, it certainly would be greatly to the advantage of many stations charging an all-round rate if they were to disconnect some of their large short-hour consumers, instead of increasing their investment in order to extend their plant.

It is obviously sound commercial practice in every line of business to encourage the profitable even at the risk of losing some of the profitless business. Under no circumstances should the supply to short-hour consumers involve a loss to the supply station or increase the charge to the more profitable classes. American central station managers were among the first to recognise that the cost of supplying a given quantity of electricity depends far more on the time over which the supply is spread than on the quantity taken. They saw the commercial unsoundness of indiscriminately supplying all consumers at the same fixed rate per lamp hour or per kilowatt hour. Like many others, however, they have been deterred from changing their method of charging by the doubt as to whether a more equitable one could be successfully carried out in practice.

If it be theoretically sound that the cost of supplying electricity generally depends on the length of time the necessary plant and mains are used, it seems an obvious corollary that the charge for the supply should conform to the same law. The author hopes to show that this principle can be successfully carried out in practice, to the great advantage both of the supply stations and of the general public. He contends, moreover, that it is impossible for a general supply to be given on an all-round price basis at so low an average cost as it can be on an equitable sliding scale. A uniform price necessitates the profitable long-hour consumers having to make up to the company the loss incurred in supplying the short-hour consumers. This unnatural condition tends to discourage the long-hour consumers, and to attract to the station a large and undesirable class, who are thereby enabled to get their supply at less than its cost. The obvious effect is to place quite an unnecessary and unwise limit to the lowering of the price at which electricity can be profitably supplied. If the principle of a sliding scale, based upon the more or less prolonged use of the maximum demand is correct, then on every consideration of practice and of policy it should be applied to each consumer without distinction. Uniform rates (*i.e.*, an even all-round charge), if high, discourage the only class of business yielding profit, and if low, mean a heavy loss on supplying short-hour consumers, which they directly encourage. Moreover, a uniform rate can never be so favourable to long-hour consumers as an equitable sliding scale.

From the figures given below, it will be seen that a uniform charge for electricity limits its use to the *few*, and that it is only by making the tariff follow the same law as the costs that the *many* can be reached. The limitation of the use of electricity to the select few has also been aggravated by the highly pernicious system of giving substantial discounts to large consumers only, irrespective of their manner of consumption.

One would think, to judge from the load-curves of many of the stations charging on the uniform price system, that nine-tenths of the population went to bed about eight o'clock in the evening; yet an immense amount of light is required right on until eleven or twelve p.m., and being a prolongation of the load on the station, can be dealt with under conditions most favourable for chief supply. As a matter of fact, in such districts it will be found that consumers pay two lighting bills—one for electricity, which by reason of the high uniform price is only used in the short-hour lamps in show places, and a second for gas or other illuminant, which is used in the long-hour burners; yet the actual conditions under which these different lights are produced and supplied favour quite the reverse order of things.

It is important to bear in mind that gas is considered good enough in a considerable proportion of the situations where artificial light is required, and competition with it in such positions must be simply on the basis of cost. The public freely admit that electric lighting is necessary for living rooms, offices, shops, theatres, and restaurants, but with electrical energy at a uniform price or other form of restrictive tariff, they are apt to remain satisfied with gas in corridors, kitchens, bedrooms, girls' workrooms, &c.

There are very few men who, having studied the question of the cost of supplying electricity, will now deny that it has to be provided and delivered under conditions essentially different from those appertaining to the supply of such commodities as gas and water; yet it is not so generally recognised as it must ultimately be, if the use of electricity is to become equally general, that those great differences in the methods of production and supply are so radical that they necessitate entirely different methods of charging.

Take the cases of gas and electricity supply; in the former, owing to the low cost and efficiency of gas storage reservoirs, one consumer taking the same quantity of gas per annum as another does, but at quite a different maximum rate, will cost the gas company practically the same amount as his fellow; whereas with electricity, owing to the greater cost of and unavoidable loss in storage batteries, as compared with the cost of boiler and steam dynamo plant of equal maximum output, it can be shown that a kilowatt-hour consumed in, say, half-an-hour, may quite possibly cost the company nearly 10 times as much as if the same consumption had been spread over 10 hours in the same day. This is owing to the capital outlay and standing charges being so enormously greater in the first case as compared with the second. Now the author challenges anyone to prove that it is either equitable or even commercially expedient to charge for these two equal quantities of electricity at the same rate per kilowatt-hour. Moreover, he asserts most emphatically that unless the charges for these equal quantities vary in about the same ratio as their respective costs, the supply companies are seriously discouraging their very best consumers and actively encouraging the most undesirable class they can have; and so long as the many-hour user of light is expected to pay the cost of keeping plant standing idle for other people, so long will he stick to gas if he is in a small way, or prefer an isolated plant if he is wealthy.

It may be said that all this is very much like thrashing a dead donkey, as many managers have long ago introduced the system of giving discounts in proportion to the number of lamp-hours consumed per lamp fixed. The author's contention is, however, that although this is an honest attempt to solve the difficulty, the counting of the lamps and estimating their current-consuming capacity is only applicable to those stations that cater merely for one line of business, such as street lighting. For any other purpose it must, for the following reasons, have a very pernicious effect on the development and extension of the supply business.

In the first place, as the discount given under this scale is frequently *inversely* as the connected load (a strange method surely of encouraging the public to give a whole-hearted support to electric lighting), a consumer usually puts in only those lamps that he can use very freely, and the longer he runs them the larger will be his "bounty" in the shape of discounts. He knows very well, however, that if he fixes any less frequently used lights, his consumption per lamp—and consequently the discount given him—will decrease, so he stops short of the number he would like to use, and electric lighting remains for him a luxury strictly confined between the limits of certain business or social requirements.

The economic disadvantage of this method of charging, then, is that it tends to contract the load curve and drive up the peak. It is obvious that the more completely a building is wired, the more natural it is that a prolonged demand for current should result; but a restrictive tariff must prevent the consumer's individual load curve being broadened out, as it might be by the use of lamps which, although not run for many hours daily, are in use at a time when many of the others are extinguished.

For the purposes of domestic lighting, and in competition with isolated plants, a tariff which is based on the connected load is usually prohibitory; a domestic supply of light is very imperfect unless it can be had when and where required, and in both of these cases it seldom happens that anything like all the lights are required simultaneously. By this method of discounts hotels and private residences, which are exceptionally good users of light, would be charged at a rate so high as to prohibit wiring throughout, although by being generally wired their individual load curves would be vastly improved. This method must also prevent large business establishments from wiring their entire premises, although probably the lights in the upper residential parts and on the staircases would be used when many of those on the lower floors were extinguished.

The second objection is, that in practice it is impossible to ascertain throughout the year with anything like accuracy the wired capacity of all the consumers' premises. This point is clear when we remember the largely varying sizes and efficiencies of lamps, and the natural (and really unobjectionable) habit of consumers in occasionally changing the candle-power of their lamps to suit their varying requirements: furthermore, it is no more equitable to estimate a consumer's actual demand from his wired capacity than it is to rate a motor at its maximum possible output irrespective of its actual current requirements.

The third great objection is the unwisdom and expense of the domiciliary searches in private houses, hotels, &c., which this system requires. These visits are highly objectionable to the consumers by reason of the intrusion upon the privacy of every part of the building; and from the company's point of view the expense entailed is considerable.

In one way or another the public has tolerated a good deal from electrical men—roof fixtures, for example—but the author's own experience has led him to the conviction that the best policy is to give them a good and steady supply on an encouraging tariff, to draw

the revenue in due season, and otherwise to trouble them as little as possible. He cannot think there is any finality in a tariff which makes it necessary for anyone to intrude on the privacy of a man's premises for the purpose of checking his connected load. Such a system, to put it mildly, leaves room for considerable inconvenience to both parties, and as we elect to call electrical engineering a tolerably exact science nowadays, the time for domiciliary visits has surely gone by. Sir Edward Coke, the great seventeenth century jurist, laid it down that "a man's house is his castle," and the saying was never truer than it is to-day. Finally, no one can pretend to say that there is any real connection between the cost of supplying a large establishment such as a hotel and the scheduled number of lamps installed.

Another system much in vogue, but having equally bad effects in stunting the profitable development of supply stations, is the unsound practice of charging a higher price for electricity consumed in lamps than for that supplied to motors or other apparatus. This method implies that the consumer who requires the use of the station plant at night should be debited with the whole of the standing charges incidental to keeping this plant ready, although the same plant may be equally used in the day time to supply another consumer's motor. Surely both of these consumers ought in common fairness to share these necessary costs.

For a *reductio ad absurdum* of this practice we have only to compare the relative profitableness of a basement user of lamps with that of an elevator motor. The former is the steadiest and longest consumer any manager can wish for, and the latter the most objectionable kind of short-time user of electricity.

In the author's opinion, one of the most profitable fields for extension lies in the displacement of isolated plants, which to-day are frequently a worry to the supply stations by requiring connections to the street mains as a stand-by against accidents. This practice forms one of the strongest reasons we can quote to show that it is just as necessary to charge each consumer the cost of keeping a proportion of the plant and mains ready to supply him as it is to make him pay in proportion to the quantity of electricity he consumes. The author maintains that by a judicious tariff the isolated plant question can be turned into a blessing instead of a trouble, and his experience leads him to believe that there should be little difficulty in obtaining practically the whole of the profitable part of this business in the form of regular customers instead of irregular worries. It is well known that isolated plants are generally installed only where the demand for electricity is of a lengthy nature, and by the application of an equitable sliding scale this very profitable business can be secured to the supply station.

That the result of such a tariff is to get this class of consumers on to a central station supply is shown in Brighton, England, where since its adoption the business formerly handled by several valuable isolated plants has been turned over to the street mains, and not a single new isolated plant has been put in.

What is there fundamental in the organism of a central station which should enable it to furnish a block with electrical energy more favourably than can be done by means of an isolated plant? Clearly it is the diversity of the duty which may be performed by the central station. The costs of a plant supplying a few premises whose requirements make their individual load diagrams pretty closely coincide must clearly be higher than those of a station catering for a wide variety of demand, and the more diversified this demand in point of time, the greater the output of electrical energy for a given investment.

On the same principle, as it is good business to encourage consumers to instal lamps which will be used at different times of the day and night, so is it most desirable, in extending the business of supply stations, to cater as much as possible for varied classes of consumers requiring electricity at different hours. This diversity of demand obviously entails a much smaller plant capacity than would be the case were all the lamps required for much the same purpose and at the same time.

From this point of view, consider the cases, say, of a large early-closing store, a theatre, and a hotel in which the bedrooms, as well as the public rooms, are wired. If each building is dealt with separately, we have three plants, each of which must be large enough to cope with the maximum requirements of its particular building: by combining the store and theatre installations part of the smaller plant of the two can be dispensed with; and if the hotel be added to the combination, the resultant maximum requirements of the three will be the lowest possible. In Brighton, where the actual demands of all the consumers are accurately known, and where the use of electricity is very evenly divided between residences and stores, this diversity factor is now no less than one-and-a-half; or in other words, if all the Brighton consumers were to require their ordinary maximum supply (not their wired capacity) at the same time the generating plant of the station would have to be increased very nearly 50 per cent. The consumers have a community of interests in flattening out the station load-curve, and they are bound to do it on a tariff which encourages them to wire their premises throughout.

The direction in which any additional capital can best be spent in the supply station business is also worthy of special study. It is very much better soon after starting the station, to run mains in all parts of the town in which artificial light is used late in the evening (although this may be in the quarters of the poorer classes of consumers) than it is to spend money on coal-saving refinements, or in running large mains for districts occupied by immense early-closing stores or by the mansions of the wealthy. Both these last-mentioned classes are very expensive to supply; the former make but a short daily use of the plant, while the latter are frequently absent from home, and the nature of their demand is generally erratic.

The author would specially urge the true economy of a liberal supply of distributing mains which can be made to serve the double purpose of supplying the street lamps as well as the general public. In this connexion he questions the wisdom of the practice of running special mains and systems for the sole supply of the public street lamps, as by so doing the total cost of supplying the whole of the requirements of the district is needlessly increased.

(*To be continued.*)

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Discussion on Mr. Trotter's Paper.

Mr. Charles Bright thought Mr. Trotter's paper was especially valuable in giving so extensive a series of experiments, which were none the less useful because they had been mostly unsuccessful. To him it appeared to be evident that the kicks on the siphon recorder were not due to direct leakage, but rather to the difference in the induction on the two lines running from the cable hut to the station. If this was so, no benefit could be derived from merely altering the position of the earth. The only way in which good results were likely to be obtained was by balancing or reducing the differential effect. He was surprised to learn that the plan tried of adding an artificial line to the cable was not a success, because theoretically it was perfect, since it was equivalent to extending the cable in such a way as to neutralise the extra induction on the other line. It was probable, however, that there would be considerable difficulty in making the required adjustments at a distance from the recorder station. It was to be regretted that no other methods had been found successful than the somewhat heroic remedy of the metallic circuit. The lesson to be learnt was that the constructors of electric tramways should take care to give cable stations a wide berth.

Mr. Preece expressed his regret that they received so few papers of the kind submitted by Mr. Trotter. This was due to the rivalry and consequent reticence of the cable companies. The Post Office had suffered considerably from disturbances due to electrical tramways, more especially at Liverpool and Leeds. There was, however, one consolation about the matter, that none of these disturbances, however bad they might be, were incurable. The principal disturbances in London were due to leakage, not to induction; the only thing left for the cable companies to do was to adopt the plan advocated by Mr. Trotter.

Mr. Luke described a case of electrical disturbance similar to that described by Mr. Trotter, which had come under his notice at Madras. They had tried earth plates at sea and earth lines along the shore, but without success. Nothing proved effectual till they ran another highly insulated line from the telegraph office to the cable house, connecting it to the guards of the cable, and so making a metallic circuit over that part of the distance. The tramway company had to reimburse the cable company the cost of making this alteration.

Mr. Gadsby had had a similar experience at Madras when in charge of the Madras electric tramways from 1894 to 1896. He had carried out, along with the Cable Company's officials, a number of experiments which seemed to indicate that the interference with the telephones was due to induction, while the interference with the cables was due to leakage. They had carried an insulated line from the siphon recorder back to the hut where the cable was landed about a mile along the shore, and made an earth on the sheath of the cable. He had recently learned that this method had not been quite successful. He thought that the disturbances recorded in Mr. Trotter's paper were neither due to induction nor leakage, but to what he called a condenser effect; currents being produced in the cable by electrostatic displacements due to the higher potential of the earth carrying electric leakage.

Prof. Ayrton had in 1893 along with Professors Rücker and Boys surveyed the neighbourhood of the South London Railway by means of a magnetometer. The effects of induction were observed 200 yards from the line, and was often greater at a greater distance. The complete remedy for all these disturbances was the insulated return. He was happy to say that the representatives of all the three companies that had Bills before Parliament that year had been so convinced that they had given undertakings that they would have a completely insulated system, and promised that the insulated return should be to his (Prof. Ayrton's) satisfaction. The scientific laboratories were, perhaps, not the least important of the vested interests which would benefit by the elimination of these electrical disturbances.

The President thought that though he was a telegraph man himself it was rather hard that cable companies who had already had an electrical monopoly of the ocean, should be allowed to annex the earth also. He thought the cases at Madras and the Cape were distinctly different.

On Dynamos. By W. M. Mordey, Member. (Paper read May 20th, 1897.)

(*Continued from page* 798.)

Sayers Winding.

23. Sayers indicated the right direction to work. The investigations of Hopkinson, Swinburne,* and others† paved the way for

* *Journal:* "The Theory of Armature Reactions in Dynamos and Motors;" Vol. xix., p. 90 (1890).

† Reference must not be omitted to Ryan's work, "Method of Balancing Armature Reactions" (*Sibley Journal of Eng.*, October, 1892). See also Ryan and M. E. Thompson, *Am. I.E.E.*, 1895—a most complete and interesting solution. An equal and opposite circle of currents is applied round the armature, counteracting the armature reaction. See also pp. 391-2, S. P. Thompson's book (1896).

Sayers, who set himself a double problem—to prevent or reduce armature reaction by collecting in a position where the armature current should assist the field, and to short-circuit active coils without sparking; and he obtained a solution of that difficult problem. By means of auxiliary coils connected between the ordinary coils and the commutator, but which were idle except during the moment of commutation, he injected into the armature coils under commutation an E.M.F. counter to the mischievous spark-creating E.M.F., and so succeeded in collecting in the desirable backward position.

Ring Armatures.

24. Let us consider the ring armature, and inquire whether we have exhausted all simple expedients.

Let us vary the monotony of the ordinary Gramme winding, and find whether, by a little rearrangement, it does not give what is wanted. Consider such a winding having, say, four turns to each sector of the commutator, as in fig. 2 (i.). Call this an "element" of the winding. Now arrange that element as in fig. 2 (ii.), disposing the four turns, not all together, but two and two, with a gap between

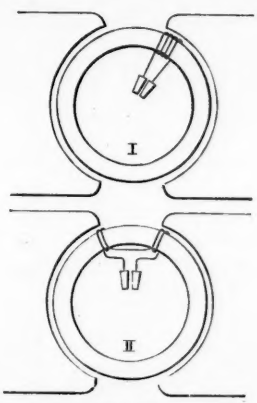


Fig. 2.

them about equal to the gap between the pole tips, and dispose all the rest of the winding in the same order, filling in the space between the parts of each element by parts of other elements. Join all the elements in series, not exactly as in the ordinary Gramme winding, but so that the current passes along each side of the armature in a series following a zigzag course, instead of the usual one. It will be observed that in each side of the armature the parts of each element, as well as the whole elements, are in series, adding their E.M.Fs. exactly as in an ordinary Gramme armature; but that when any element passes through the region between the poles

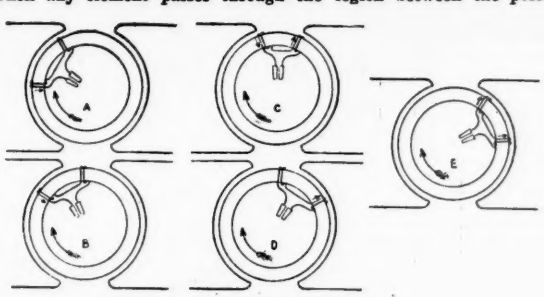


Fig. 3.

(where in an ordinary winding it would be adding nothing useful to the circuit), it becomes the seat of two opposing E.M.Fs., and that when those opposing E.M.Fs. are equal the element may be short circuited without any current being generated in it, although in each part there is a strong E.M.F.

25. Fig. 3 shows five successive positions of an element in its passage from one side of the field to the other.

Fig. 4* shows more clearly the winding of a single element and parts of others; fig. 5 is a diagram showing a complete armature; and fig. 6 is a diagram of an extended portion of an armature, showing the connections of the elements, and the directions of the current in them. To distinguish it, the element under commutation is shown thicker than the others. The field winding is shown by large black circles, and the two directions of the armature current are indicated respectively by small black circles and by dotted circles. It is important that the armature coils should show black circles rather than dotted circles, because the black circles are what are wanted in the magnetising space. On the other side of the armature the conditions would, of course, be reversed—the magnetising space containing dotted circles, and the armature conductors should show as dotted circles. In practice there is not so great a gain with this particular arrangement as the diagram shows, because of the cross induction and the slight movement for the reversal of the current. The relative value of this gain depends, of course, upon the initial value of the excitation. A reference to the results quoted further on shows that it may amount to a saving of about half the ordinary field winding, and that a further saving may arise from the possible lowering of the initial excitation.

26. Figs. 5 and 6 show that this winding is quite symmetrical; the armature may be run in either direction, exactly as with the ordinary winding. Within the span of the element under commutation the armature conductors carry currents which alternate in direction, so that from this part of the winding there is no reaction on the field. It may be supposed there is some loss of volts, as the volts and current in the conductors comprised within this span are alternately in the same and in opposite direction to the E.M.F.; but this loss is not appreciable at no load, as might be expected from the small E.M.F. near the neutral line. As the load rises there is a rapid and marked gain in E.M.F. as compared with an ordinary winding.

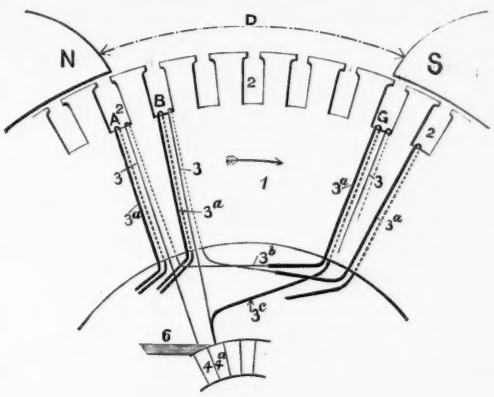


Fig. 4.

It may be supposed that with this winding the breadth of the neutral line must be narrow, but this will not necessarily be the case if the slope of the field is slight in the regions occupied by the parts of the element under commutation.

27. Other ways of arranging the element will suggest themselves, both as to the distribution of its parts and the span. Fig. 7 shows an element of four horns divided into two unequal portions—one

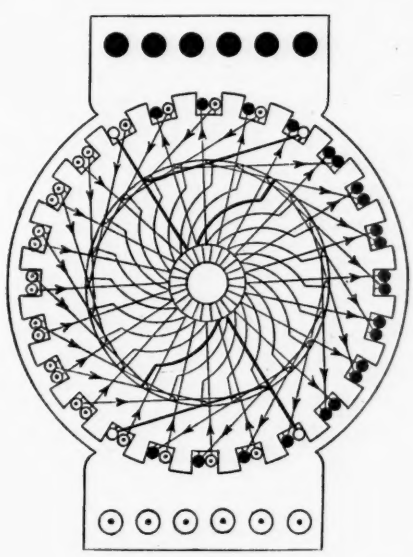


Fig. 5.

and three, instead of two and two, the three horns leading. With such an element a balance would be obtained at no load when the leading part was in a much weaker field than the lagging part—a condition obtainable either by making the span less than that of the pole-tips, or by making the clearance less at the leading horn than at the lagging horn. The effect of such an unequal division of the element on the magnetising space is seen in fig. 8, which shows that there is a considerable strengthening reaction in that space as the load comes on. As compared with the usual loss of effective magnetising force, this may be very useful. And of course it is applied exactly where it is most effective in magnetising the armature. By proportioning the element in this way, the armature reaction may be utilised either for strengthening or weakening the effective field—as, for example, by "compounding up" in a dynamo, or "down" in a motor.

* This figure is from a forthcoming publication; it is not necessary to explain the letters of reference here.

28. Summarising the foregoing, we see that good results may be obtained by the use of toothed cores and windings, disposed so that at no load equal and opposite E.M.Fs. are produced in the connected portion of each element, the elements being so arranged in a series that, during the greater portion of the revolution, the E.M.Fs. in each element are additive, and that during commutation they are in opposition; commutation taking place, not when any coil is on or

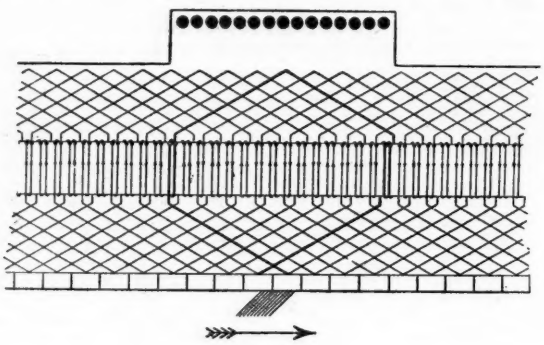


Fig. 6.

near the neutral line, but when it is away from that line. The coils in the neutral region being arranged in such an order that successive coils are traversed in opposite directions by the current, irrespective of their own E.M.Fs., and in virtue of which altenation of direction, these coils cease to exert any influence in the "magnetising space." Or, by a modification in the proportions of the element, we have seen how the armature current may, as desired, be caused either to increase or to diminish the magnetising force acting in the magnetising space.

29. Results have been obtained by testing a toothed Gramme machine of "Manchester" type, wound as in figs. 5 and 6; it gave

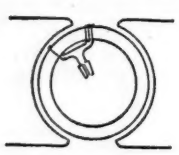


Fig. 7.

an output, with good collection, about one-third more than could have been satisfactorily taken from a smooth core machine of this type. It was a 15-kilowatt machine, and at this load attained a rise of only 30° Fahr. after a prolonged run. The current density in the armature was about 1,500 amperes per square inch; this low temperature was undoubtedly due to the exposure of the core, and to the absence of eddies in the conductor. The full load excitation was only

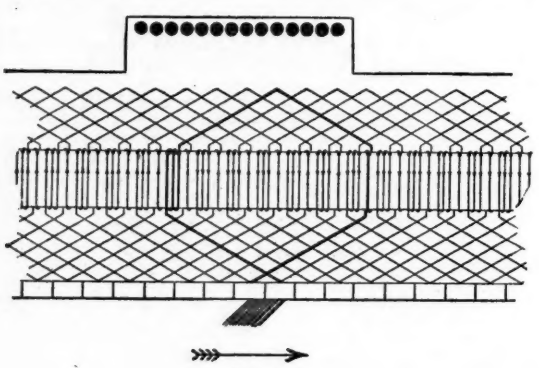


Fig. 8.

about 1 per cent., without an extravagant amount of copper in the fields. The reaction was so slight that by careful adjustment of suitable brushes it was found impossible to tell by an examination of the brushes whether the full load was on or off, the brushes being fixed. The armature had 48 slots, a 48-sector commutator, four turns in each slot, and ran at 1,100 revolutions per minute. The machine was run as a motor, and with fixed brushes and varying load it gave equally good results.

Drum Armatures.

30. Gramme dynamos have been particularly studied in the foregoing section, because it was in connection with such machines that the present consideration of the subject began, and because it is easier to trace the various actions in such armatures than in drums. When we turn our attention to drums, we find one important difference. In a drum each turn or coil has, or may have, two separate and distinct E.M.Fs. simultaneously impressed on it, as against one in a Gramme. This makes the study of drums somewhat less easy than rings. But bearing this difference in mind, it is obvious that all the main considerations put forward apply equally to the two kinds of armature. It is only necessary to so arrange the winding that the circle of conductors seen in section surrounding the core shall present the same order in the two cases.

31. In endeavouring to obtain the same effect in a drum armature, the first and obvious course is to form an element, as in the Gramme winding, of two turns joined in series, each turn wound, as usual, over a diameter, or an approximate diameter, but the two crossing one another at the required angle to give them the same relative positions on the core, or the same relative E.M.Fs. as in the Gramme. But, since each turn has two separate and distinct E.M.Fs., we at once observe that this procedure may be simplified by so disposing the two halves of each turn that the parts of a single turn will occupy the required relative positions and form a complete element; that is to say, we may wind the single turn, not across a diameter, as usual, but across such a chord that its two portions comply with the conditions stated in the preceding paragraph. And by so winding and so connecting the turns in the required order we get nearly all that is desired. Such a winding will give us conditions equivalent to those shown in figs. 5 and 6. And if we wish to go further and to obtain conditions equivalent to fig. 8, and we cannot find a chord capable of giving what we want, we may use a double turn of any combination of chords we desire.

(To be continued.)

ON THE CAPACITY AND RESIDUAL CHARGE OF DIELECTRICS AS AFFECTED BY TEMPERATURE AND TIME.*

By J. HOPKINSON, F.R.S., and E. WILSON.

(*Continued from page* 781.)

Residual Charge as Affected by Temperature.

Experiments on this subject have been made by one of us which showed that residual charge in glass increases with temperature up to a certain temperature, but that the results became then uncertain owing to the conductivity of the glass increasing. These experiments were made with an electrometer, the charge set free in the flask being measured by the rate of rise of potential on insulation. We now replace the electrometer by a delicate galvanometer and measure the current directly without sensible rise of potential.

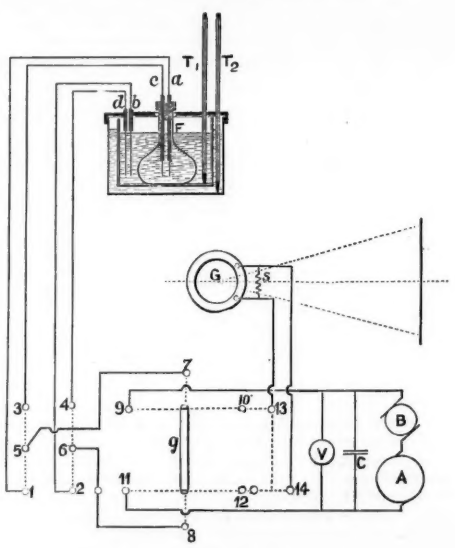


Fig. 1.

Fig. 1 gives a diagram of connections. The glass to be experimented upon is blown into a thin flask, F, with thick glass in the neck to diminish the effect of charge creeping above the level of the acid, and is filled with sulphuric acid to the shoulder; it is then placed in sulphuric acid in a glass beaker, which forms the inner lining of a copper vessel consisting of two concentric tubes between which oil is placed. Thermometers, T_1 T_2, placed in the acid outside the jar and in the oil, are made to register the same, or nearly the same, temperatures when taking observations, but T_1 gives the temperature taken for the flask. The flask is heated by a Bunsen burner placed under the copper vessel. Two electrodes *a*, *c*, insulated from one another, and from the flask by means of sealing wax and glass tubes, dip into the sulphuric acid forming the inner coating of the jar, and similarly, electrodes *b*, *d* dipping into the outer acid make

* Royal Society Paper. Received December 15th, 1896—Read January 28th, 1897.

connection with the outer coating. The acid inside and out was made to wet the flask up to a level higher than the acid would reach at the highest temperatures.

The four electrodes, *a*, *b*, *c*, *d*, are connected respectively by thin copper wires, with four mercury cups 1, 2, 3, 4, cut in a block of paraffin, and, by means of a reversing switch *a*, *b* and *c*, *d*, can be connected respectively to mercury cups 5, 6. Cups 5, 6 are connected respectively to 7, 8 by thin wires, which can in turn be connected with or disconnected from the source of charge 9, 11.

The steady potential difference of about 1,500 volts is obtained from a Siemens alternator, A, in series with a revolving contact maker, B, fixed to the alternator shaft and making contact once per complete period, there being six periods per revolution. The contact-maker is set to make contact when the potential difference is a maximum. A condenser, C, and a Kelvin vertical electrostatic voltmeter, V, are placed in parallel between the connecting wires leading to mercury cups, 9, 11.

The galvanometer, G, has a resistance of 8,000 ohms and is inclosed in an iron box which acts as a magnetic shield. The box is supplied with a small window for the ray of light to pass through it from an incandescent lamp to the mirror from which it is reflected back through the window to a scale at a distance of 12 feet from the mirror. The divisions on this scale are $\frac{1}{10}$th of an inch apart, and an average sensibility for this instrument is $\cdot 3 \times 10^{-9}$ ampere per division of the scale. The galvanometer is supplied with the shunt, S, and has its terminals connected to mercury cups 13, 14 on the paraffin block. These mercury cups are connected to cups 10, 12 respectively, which can at will be connected to 7, 8, by one motion of the glass distance-piece, *g*, forming part of the reversing switch which places 9, 11, or 10, 12, in contact with 7, 8. A switch is so arranged that 13, 14 can be connected at will, that is, the galvanometer is short-circuited.

The process of charging, discharging, and observing, is as follows:—Near the observer is a clock beating seconds which can be distinctly heard by the observer. Initially, the cups 9, 11, are disconnected from 7, 8; but 5, 1, and 6, 2, are connected. At the given moment the reversing switch is put over connecting 7, 9, and 11, 8; the jar is then being charged through electrodes *a*, *b*. This goes on for the desired time, during which charging volts and zero of the instrument are noted. At the end of the time required for charge, the main reversing switch is put over connecting 7, 10, and 8, 12; next the subsidiary switch is put over connecting 3 to 5 and 4 to 6, and on opening the short-circuiting switch, the spot of light is deflected and allowed to take up its natural state of movement determined by residual charge, readings being taken at stated epochs after discharge is started. This whole operation, including an adjustment of the shunt when necessary, was so speedily accomplished that reliable readings could be taken 5 seconds after discharge is started. By using two electrodes, polarisation of electrodes is avoided, and the gradually-diminishing current through the galvanometer is that due to residual charge. The conductivity of the jar is determined by removing the glass distance piece, *g*, connecting 7 to 9, 8 to 12, and 10 to 11, and noting the steady deflection on the galvanometer for a given charging potential difference.

In the ice experiment, the conductors from 3, 4, are used both for charging and discharging. The form of condenser used when dealing with ice and liquid dielectrics is shown in fig. 2. It consists of seven

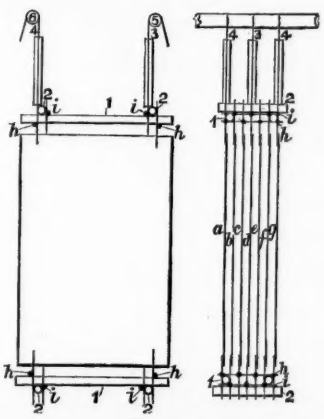


FIG. 2.

platinum plates, *a*, *b*, *c*, *d*, *e*, *f*, *g*, each measuring 2 inches by 3 inches, and of a thickness ·2 millim., separated from each other by a distance of 2·7 millims. To each plate are gold-soldered four platinum wires—two top and two bottom. Plates *a*, *c*, *e*, *g*, form the outer coating of the condenser, and are kept in their relative positions by cross connecting wires, *h*, gold-soldered to the wires at each end of each plate. Similarly, plates *b*, *d*, *f*, which form the other and inner coating of the condenser, are fixed relatively to one another by cross connecting wires, *i*. The relative positions of the two sets of plates are fixed by glass rods 1, 2. The terminals of the condenser are, for the inner plates the prolonged wire 3, and for the outer plates the wires, 4, 4. These are bent round glass rods, 5, 6, which resting on the top of a beaker support the plates in the fluid. The glass tubes on the wires, 3, 4, 4, are for the purpose of securing good surface insulation. The glass beaker is conical, so as to remain unbroken when freezing the distilled water within. This was accomplished by surrounding the beaker with a freezing mixture of ice and salt, the lower temperature being obtained by further cooling in carbonic acid snow.

The same blue flask, which was the subject of the earlier experiments, was mounted as shown in fig. 1, and the residual charge observed for various temperatures. This glass is composed of silica soda and lime; the colour is due to oxide of cobalt in small quantity.

Out of a large number of experiments the data in Tables I. and II. give the general character of the results.

TABLE. I.

Time in seconds.	15° C.	34½.	54½.	70.	85.	117.	132.
10	246	...	...	...	...	9,770	7,256
15	...	376	1,176	2,785	5,445	...	...
20	121	265	1,030	2,586	4,100	3,590	3,010
30	87	209	892	2,070	2,980	2,150	1,735
60	46	131	633	1,320	1,510	950	778
120	22½	91	483	720	688	440	350
300	9½	62	256	260	210	164	107
600	...	...	123	110	...	... 86	less than 59

Remarks.—Blue flask. November 6th and 7th, 1894. Sensibility of galvanometer, ·378 × 10^{-9}. Duration of charge, 2 minutes. Charging volts, 1,250.

TABLE II.

Time in seconds.	14° C.	55.	70.	110	137.	Remarks.
10	205	...	...	11,740	12,400	Blue flask. November 13th, 1894. Sensibility of galvanometer, ·407 × 10^{-9}. Duration of charge, 2 min. Charging volts, 1,250.
20	99	1,230	2,850	4,790	4,340	
60	38	837	1,560	1,212	990	
120	17	594	878	487	366	
300	5	308	314	134	...	

TABLE III.

	January 3rd, 1895.			January 4th, 1895.			
Time in seconds.	8° C. 5 min. charge.	117 1 min.	117½ 1 min.	8° C. 5 min. charge.	122 1 min.	122½ 1 min.	Remarks.
10	75	...	258	70	...	1,100	New window glass flask. Sensibility of galvanometer, ·358 × 10^{-9}. Resistance of flask, 8° C., 3,340 × 10^6 ohms. Charging volts, 1,500.
20	43	123	148	44	...	664	
30	30	105	109	32	400	...	
60	18	80	73	19	240	240	
180	7½	...	56	7⅜	69	68	

The figures given are the deflections of the galvanometer in scale divisions corrected for the shunt used. Recalling that one scale division means a known value in amperes, that a known potential in volts is used, these figures can readily be reduced to ohms $^{-1}$. The capacity of the flask is 0·0026 microfarad at ordinary temperatures and times, and the specific inductive capacity of its material under similar conditions is about 8. Hence one could reduce to absolute conductivities of the material. It is more interesting to consider how fast the capacity is changing. Take the first result given in Table III. for another flask 75 at 10 seconds; this means a conductivity $75 \times 0{\cdot}358 \times 10^{-9}/1{,}500$ = about $0{\cdot}179 \times 10^{-10}$, and this is, of course, the rate in farads per second at which the capacity is changing in that experiment compared with a capacity of the flask ¼ 10^{-3} microfarad measured with the shortest times, or, to put it shortly, the flask owing to residual charge is changing capacity at the rate of about 3 per cent. per second. These figures also show that the residual charge up to 20 seconds increases greatly with the temperature; the residual at 60 seconds rises with the temperature up to about 70° C. or 80° C., and then diminishes; residual charge at 300 seconds begins to diminish at about 60° C. One may further note the way in which the form of the function $\psi(\omega)$ changes as temperature rises. Compare in Table I. the values for 20 and 30 seconds, the ratios are:—

Temperature ...	15	34½	54½	70	85	117	132
Ratio ...	1·39	1·27	1·16	1·25	1·38	1·67	1·74

In other words, if we express $\psi(\omega)$ in the form c/t^m, we should find m first diminishes as temperature rises to 54°, then increases as the temperature further rises. This has an important bearing upon the effect of residual charge on apparent capacity and resistance.

It will be noticed that the residual charge, for the same time, at high temperatures, is somewhat greater in Table II. than I. The results in Table I. were obtained on November 7th, 1894; those in Table II. on November 13th, 1894. There is no doubt but that heating this glass and submitting it to charge when heated, alters the character of the results in such manner as to increase residual charge for high temperatures. To test this more thoroughly, a new flask was blown out of window glass composed of silica lime and soda without colouring matter, and on January 3rd, 1895, was charged and discharged in the ordinary manner. After the results given in Table III. for January 3rd were obtained, the flask was charged for

21 minutes at 1,500 volts, the direction of charge being reversed after 10 minutes, the temperature of the flask being 133°. We see that on January 4th, Table III., the same effect is observed, namely an apparent increase in residual charge for the same time at high temperatures. This may probably be attributed to a change in the composition of the material by electrolysis.

Capacity.

(A). *Low Frequency.*

Fig. 3 gives a diagram of connections, showing how the apparatus is arranged for the purpose of determining the capacity of poor insulators, such as window glass or ice, at varying temperatures. This is a bridge method, the flask, F, being placed in series with a condenser of known capacity, K, and on the other side non-inductive resistances, B_1, B_2. By means of keys k_1, k_2, the bridge can be connected to the poles of a Siemens alternator, A; its potential difference is measured on a Kelvin multicellular voltmeter, V. On the shaft of the alternator is fixed the revolving contact-maker, B, which makes contact once in a period, and the epoch can be chosen.

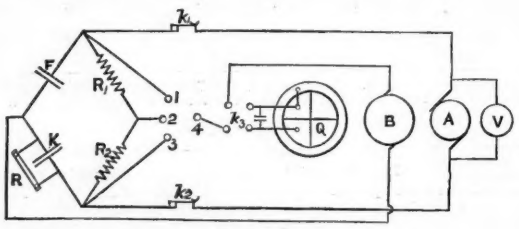


Fig. 3.

The Kelvin quadrant electrometer, Q, has one pair of quadrants connected to a pole of the revolving contact-maker B, and the other to a mercury cup, 4, in a block of paraffin. The other terminal of B is connected to the junction between F and K; by means of mercury cups, 1, 2, 3, the electrometer can be connected through the contact-maker to either end, or to the middle of the bridge.

The compensating resistance, B, is the resistance due to pencil lines drawn on fine obscured glass strip,* about 12 inches long and ½-inch wide, contact being made at each end by means of mercury in a small paraffin cup, and the whole varnished whilst hot with shellac varnish. A series of these resistances was made, ranging in value from a few megohms to a few tens of thousands of ohms. For the purpose of these experiments a knowledge of their actual resistance is of no moment, although for the purpose of manipulation their resistances are known.

The method of experiment is as follows: Mercury cups, 1 and 4, are connected by a wire, placing the electrometer and contact-maker across F, and the contact-maker is moved until it indicates no potential. Cups 3, 4 are now connected, and resistance, B, is adjusted until the electrometer again reads zero. After a few trials, alternately placing the bridge between 1, 4 and 3, 4, and adjusting B, the potentials are brought into the same phase, that is, the potential across the electrometer is zero in each case for the same position of the contact-maker. Mercury cups 2, 4 are now connected, the contact-maker B is adjusted to the point of maximum potential, and B_1, B_2 adjusted until balance is obtained. We now know that $K/F = B_1/B_2$.

k_3 is the ordinary key supplied with the electrometer, which reverses the charge on the quadrants or short-circuits them. The range of frequency varies from 100 to 7 or 8 complete periods per second.

(*To be continued.*)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

19,455A. "Improvements in automatic switches and safeguards for electric traction systems." S. P. Thompson and M. Walker. (Date claimed under Patents Rule 19, September 3rd, 1896.) Dated May 27th, 1897.

12,758. "An improved form or construction of pipes for the reception of electric cables." J. J. Green and W. Oates. Dated May 24th.

12,784. "The search-light electric lamp." T. S. Hill and Peto and Radford, Ltd. Dated May 24th.

12,809. "Improvements in electric cables and in the manufacture of the same." M. J. P. O'Gorman. Dated May 24th.

12,820. "Improvements in transforming continuous electric currents." A. Muller and H. Tudor. Dated May 24th.

12,827. "Improvements in electric primary and secondary batteries." V. Jeanty. (Date applied for under Patents, &c., Act, 1883, Sec. 103, 19th November, 1896, being date of application in France.) Dated May 24th.

12,875. "Improvements in submarine cable laying appliances." C. S. Snell. Dated May 25th.

12,910. "Improvements in telephone-receiver supports." L. Duque and F. M. Cosgrove. Dated May 25th. (*Complete.*)

12,933. "A general switch for groups of electric lamps." O. Imbay. (The firm of R. Kissling & Sohn, Hungary.) Dated May 25th. (*Complete.*)

12,935. "Improved apparatus for supporting and securing electrical conductors and for like purposes." H. T. Marks. Dated May 25th.

12,936. "Improvements in electric furnaces." A. V. Newton. (A. H. Cowles, United States.) Dated May 25th. (*Complete.*)

12,944. "Improvements in electric tramways." H. Bersier. Dated May 25th.

12,945. "An improved electric arc lamp." F. Fesquet and J. W. Keys.

12,957. "Improvements in transforming alternating into continuous electric currents or *vice versâ*." A. Muller and H. Tudor. Dated May 25th.

12,974. "Improvements in electrical telegraph systems and apparatus therefor." H. H. Lake. (C. G. Burke, United States.) Dated May 25th. (*Complete.*)

12,980. "Improvements in electrical apparatus usually known as induction coils." H. C. L. Holden. Dated May 27th.

13,049. "Improvements in enclosed arc lamps." B. M. Drake and J. M. Gorham. Dated May 27th.

13,100. "Improvements in or connected with primary or galvanic electric batteries." C. N. Gauzentes. Dated May 27th.

13,107. "Improvements in electric arc lamps." S. Bergmann. Dated May 27th. (*Complete.*)

13,117. "Improvements in electric meters for alternating currents."

13,154. "Improvements in attachments for operating telephone call-bells." H. W. Libbey. Dated May 27th.

13,164. "Improvements in construction of dynamo-electric armatures." R. E. B. Crompton. Dated May 27th.

13,212. "Improvements in or additions to the covers or casings of switches, cut-outs, ceiling roses and other electrical fittings." T. Taylor. Dated May 28th.

13,213. "Improvements in the tubes and cases of electric fuses." T. Taylor. Dated May 28th.

13,221. "Improvements in electrical cut-outs." C. M. Dorman and R. A. Smith. Dated May 28th. (*Complete.*)

13,236. "The Bolton improved incandescent electric glow lamps." J. I. Bolton. Dated May 28th.

13,257. "Improvements in or relating to the feed mechanism of arc lamps." C. Oliver. Dated May 28th.

13,268. "Improvements in electric mountain railways." E. Andre. Dated May 20th. (*Complete.*)

13,282. "An electric igniter for gas burners." L. V. Lewitzki. Dated May 28th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps*).]

1896.

868. "Improvements in electric meters." C. Raab. Dated January 13th, 1896. Relates to alternating current meters of the motor type. A metallic disc is set in rotation by the action of two solenoids included in the main circuit, and two electro-magnets whose exciting coils are in shunt therewith. The solenoids are arranged between the poles of the electro-magnets with their axes perpendicular to the plane of the disc. In one modification the solenoids are partly surrounded by the magnet poles, while in another the armature is in the form of a hollow cylinder inside and outside of which are arranged the solenoids and electro-magnets. 2 claims.

2,772. "Method and apparatus for effecting the connection in parallel of alternate current and polyphase dynamos and motors." Siemens Bros. & Co., Ltd. (Siemens & Halske, Berlin). Dated February 6th, 1896. Relates to a method of facilitating the connection in parallel of single or polyphase alternate current machines, consisting in so connecting circuits having three or more glow lamps between the terminals having different phases of the machines to be connected in parallel, that the sequence of the consecutively occurring incandescence of the glow lamps during a synchronous motion will indicate which of the machines is running faster or slower than the other. 8 claims.

3,409. "Improvements in or connected with recording electric meters." A. Wright. Dated February 14th, 1896. Relates to improvements in recording electric meters and consists of a graduated scale attached to the bottom of the core of a solenoid, the core being supported by a spring tending to withdraw it from the solenoid and the scale dipping into a suitable liquid contained in a vessel. On the passage of a current through a solenoid the core is sucked into the said solenoid. The greater the current the further will the core be sucked into the solenoid, the deeper will the scale dip into the liquid, and the greater will be the amount of liquid which will adhere to the scale and be withdrawn therewith when the deflection ceases or diminishes. In practice, one of the usual devices for keeping the level of the liquid in its vessel constant would be employed and the liquid would be strongly coloured so as to leave a stain on the scale. The level of the stain on the scale will record the greatest current that has passed during the period that the device has been under its influence. 8 claims.

* See *Phil. Mag.*, March, 1879.